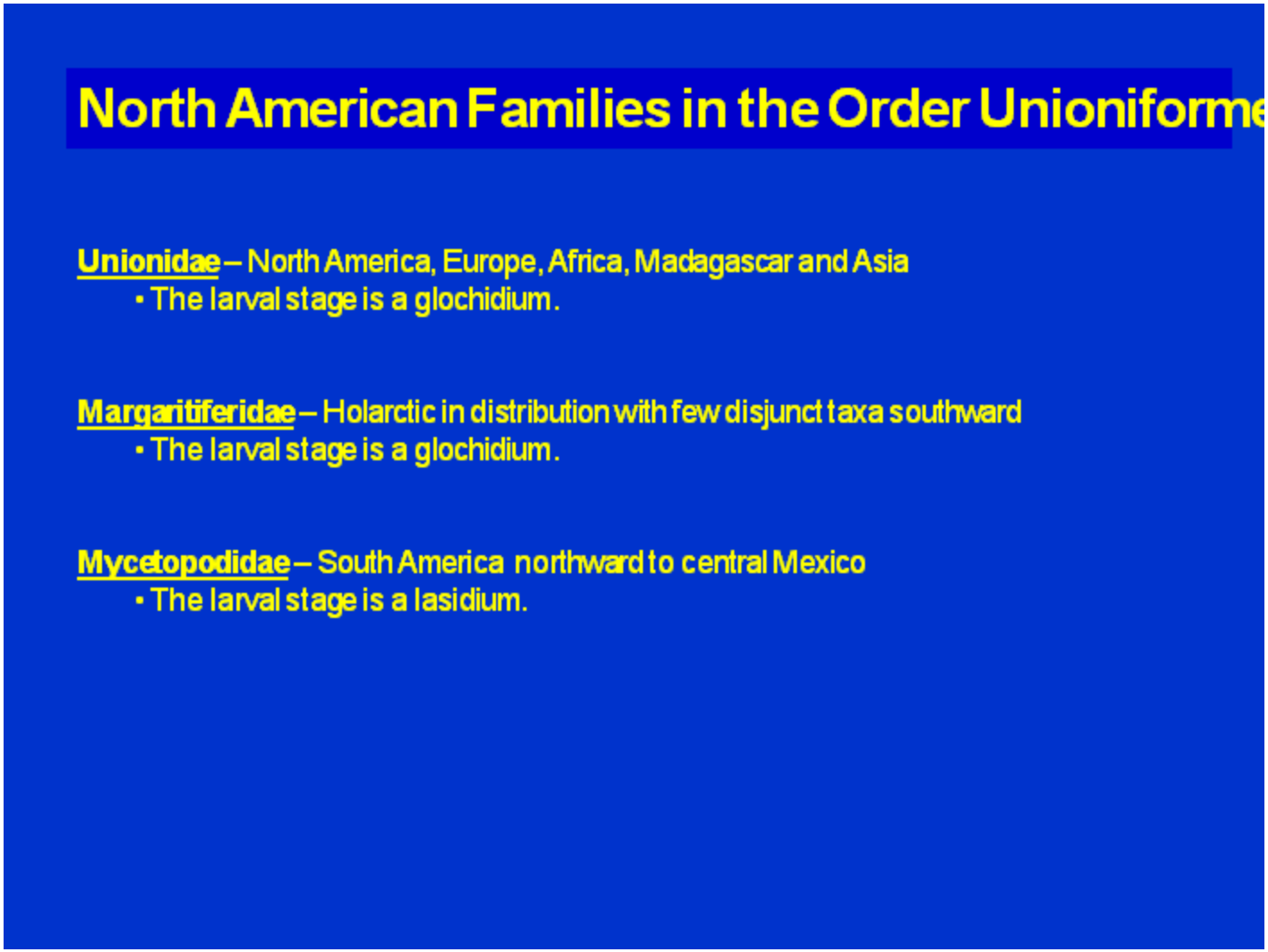

Freshwater Mussels: Biology and Conservation of a Neglected Resource

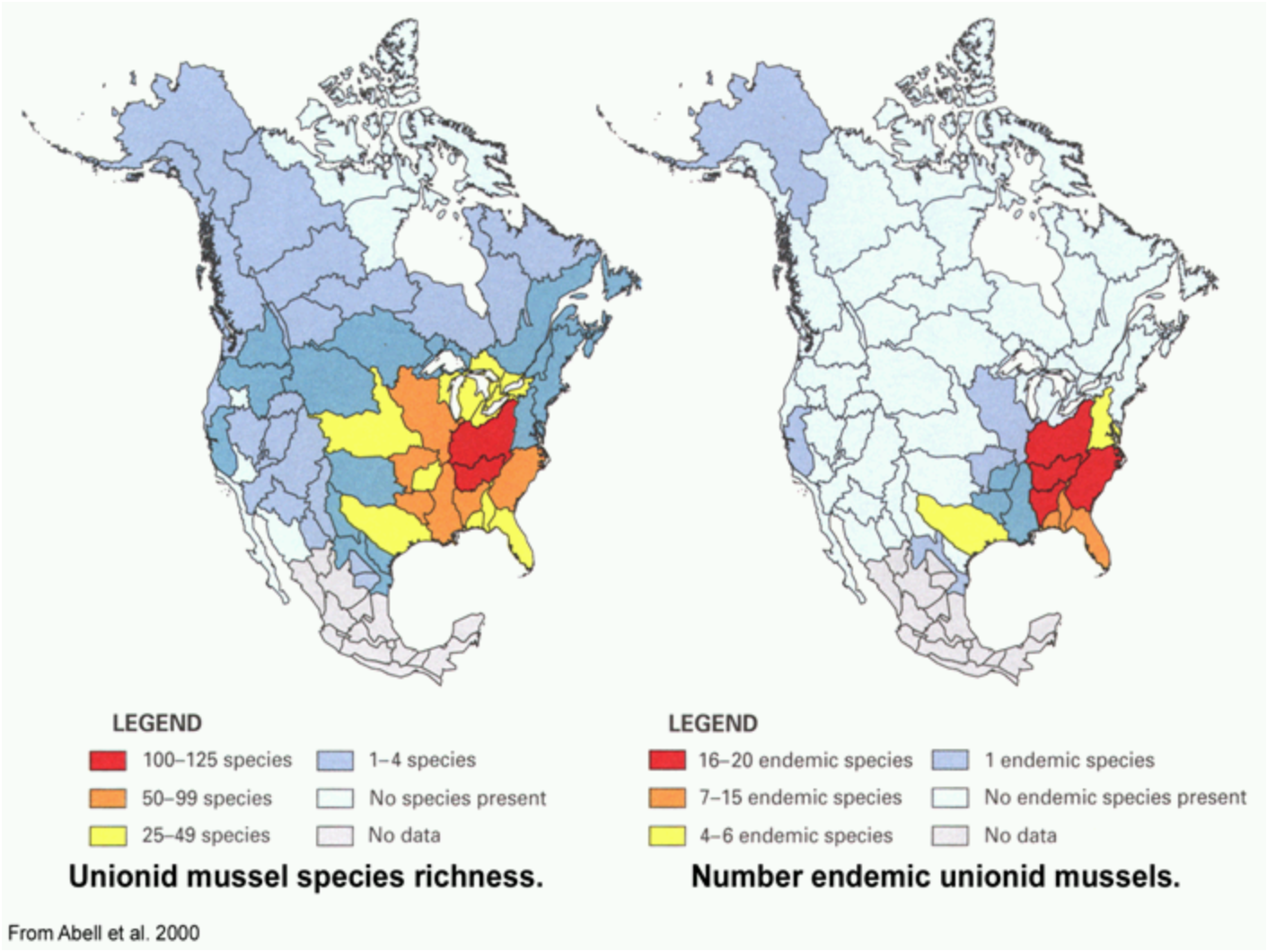
Slide 1


North American Families in the Order Unioniforme
Unionidae – North America, Europe, Africa, Madagascar and Asia
• The larval stage is a glochidium.
Margaritiferidae – Holarctic in distribution with few disjunct taxa southward
• The larval stage is a glochidium.
Mycetopodidae – South America northward to central Mexico
• The larval stage is a lasidium.

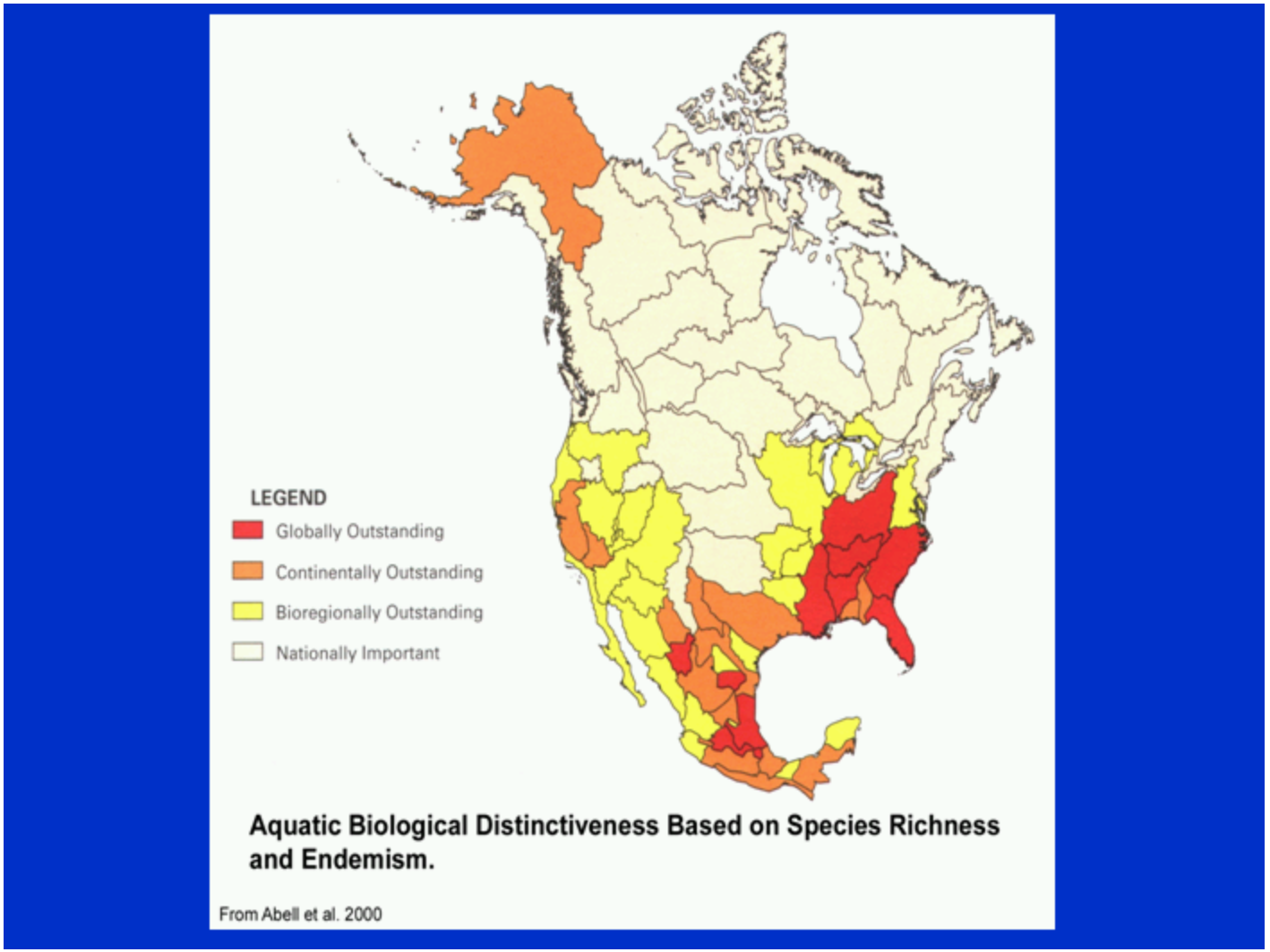
Slide 2


Freshwater Mussels in the United States
Mussel Families in United States – 2
Family Unionidae – (Often split into 3 subfamilies)
46 Genera and about 300 species
Family Margaritiferidae – 2 Genera and 5 species

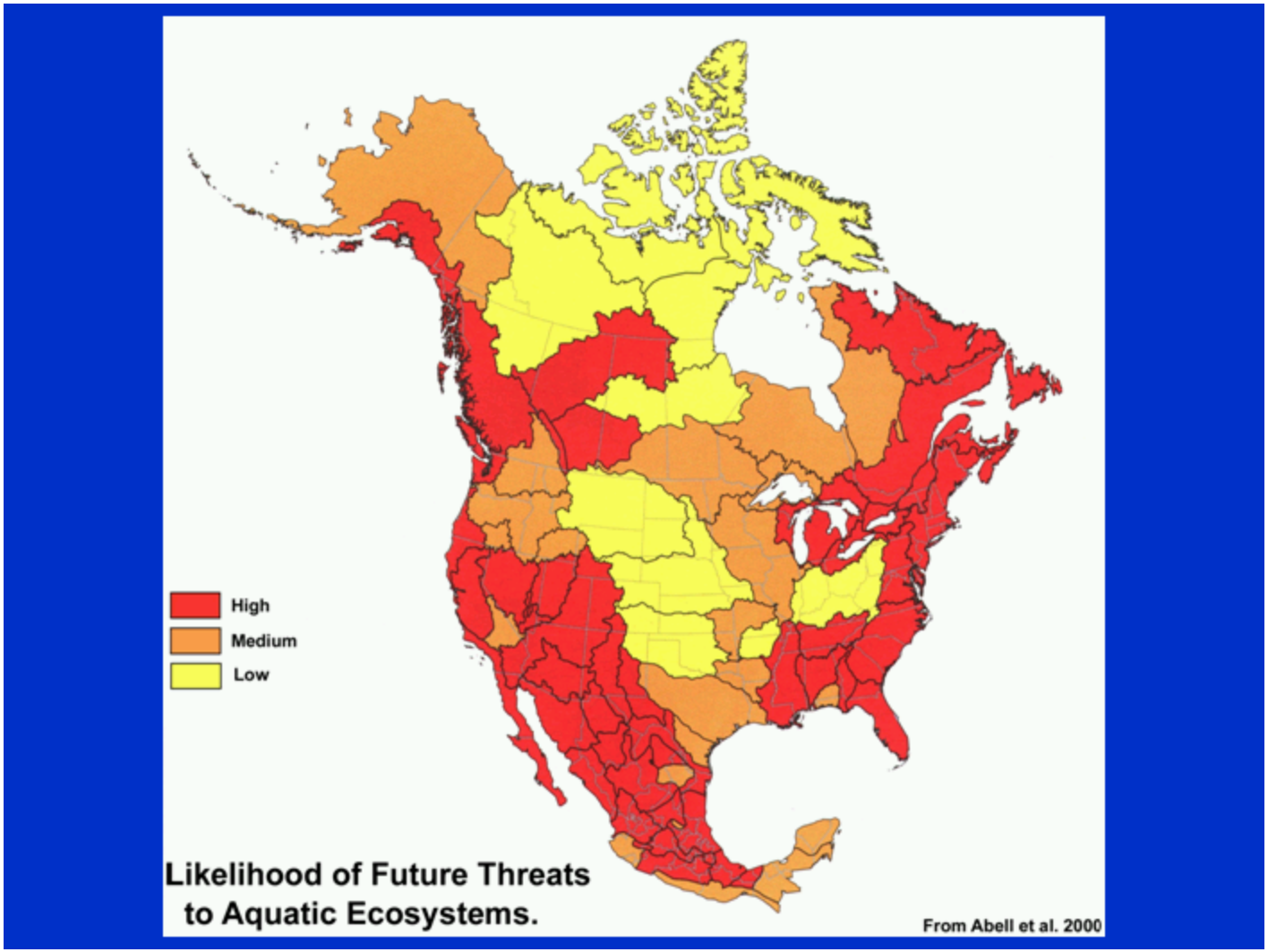
Slide 3


LEGEND
100–125 species
50–99 species
25–49 species
1–4 species
No species present
No data
Unionid mussel species richness.
LEGEND
16–20 endemic species
7–15 endemic species
4–6 endemic species
1 endemic species
No endemic species present
No data
Number endemic unionid mussels.
From Abell et al. 2000

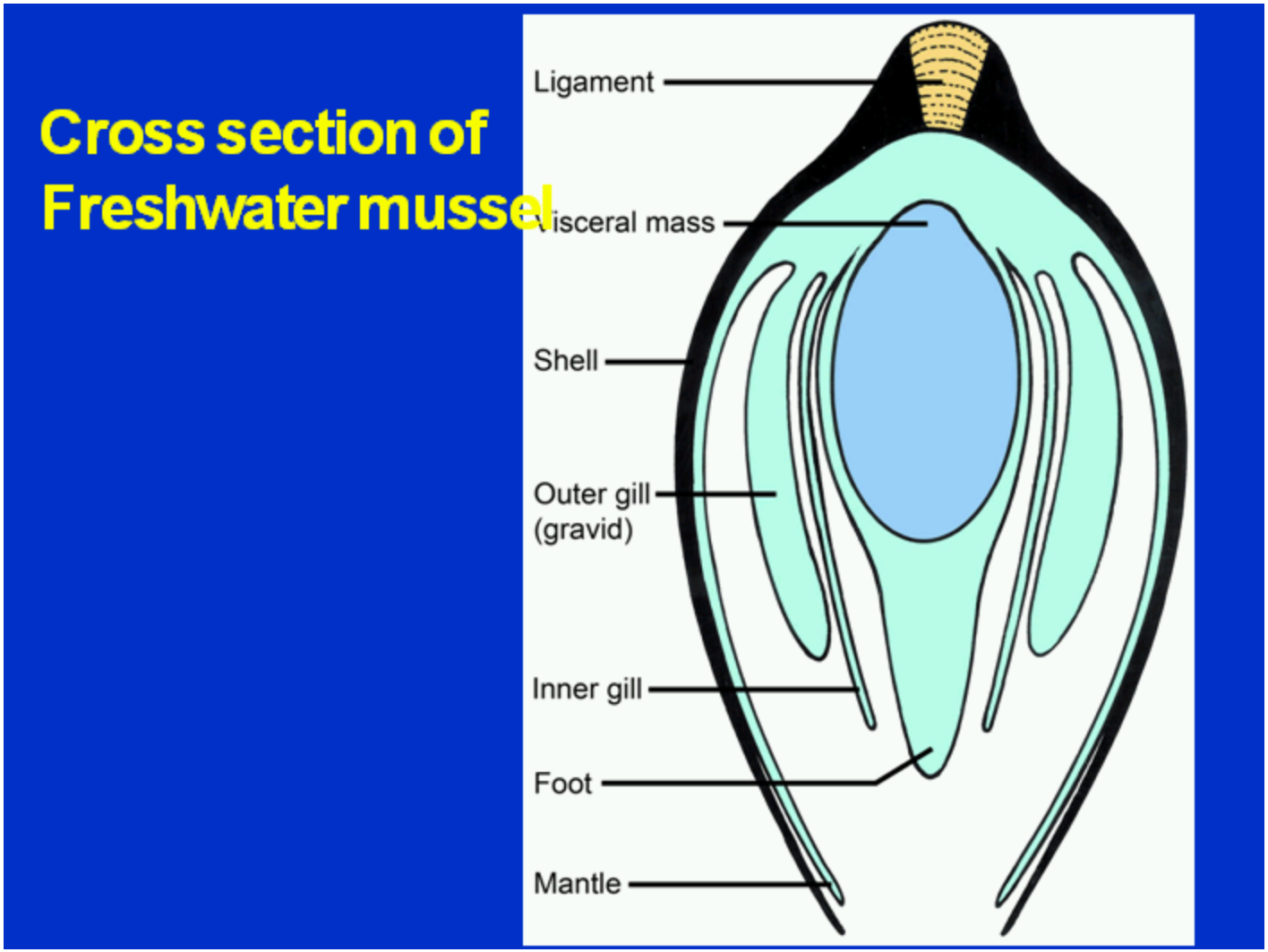
Slide 4


LEGEND
Globally Outstanding
Continentally Outstanding
Bioregionally Outstanding
Nationally Important
Aquatic Biological Distinctiveness Based on Species Richness and Endemism.
From Abell et al. 2000

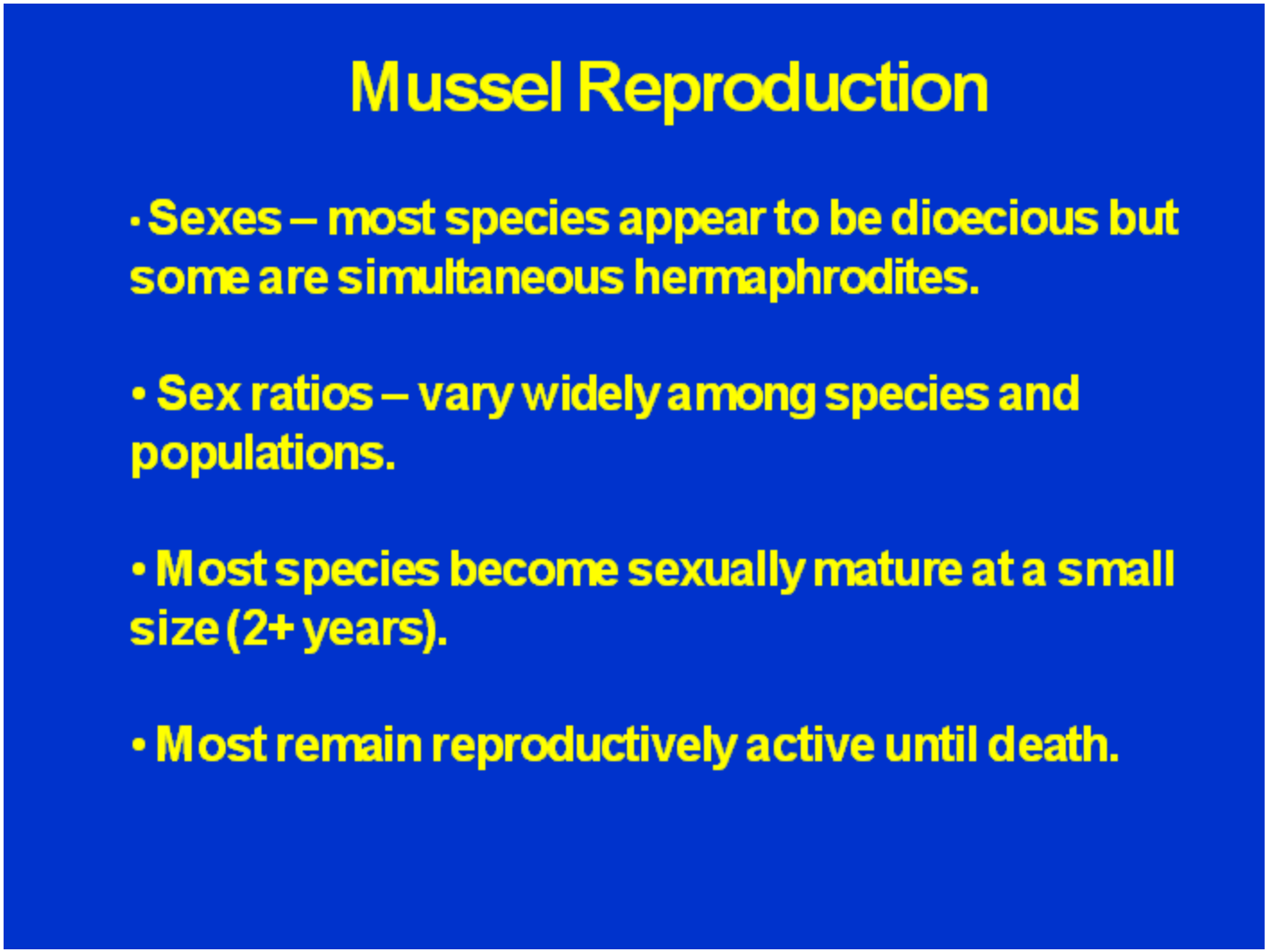
Slide 5


High
Medium
Low
Likelihood of Future Threats
to Aquatic Ecosystems.
From Abell et al. 2000

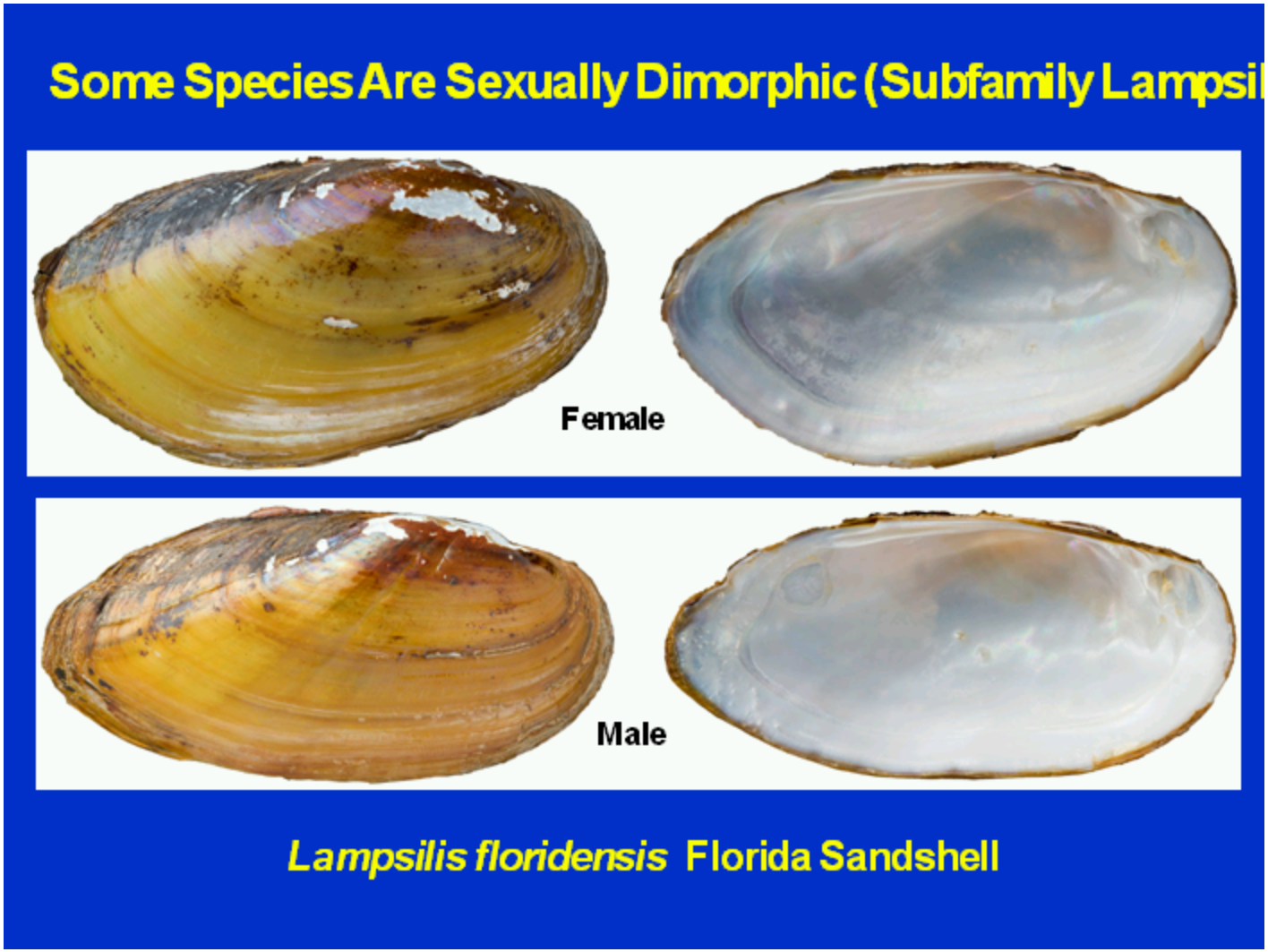
Slide 6


Cross section of
Freshwater mussel
Ligament
Visceral mass
Shell
Outer gill
(gravid)
Inner gill
Foot
Mantle

Slide 7


Mussel Reproduction
• Sexes – most species appear to be dioecious but some are simultaneous hermaphrodites.
• Sex ratios – vary widely among species and populations.
• Most species become sexually mature at a small size (2+ years).
• Most remain reproductively active until death.

Slide 8




Lampsilis floridensis  Florida Sandshell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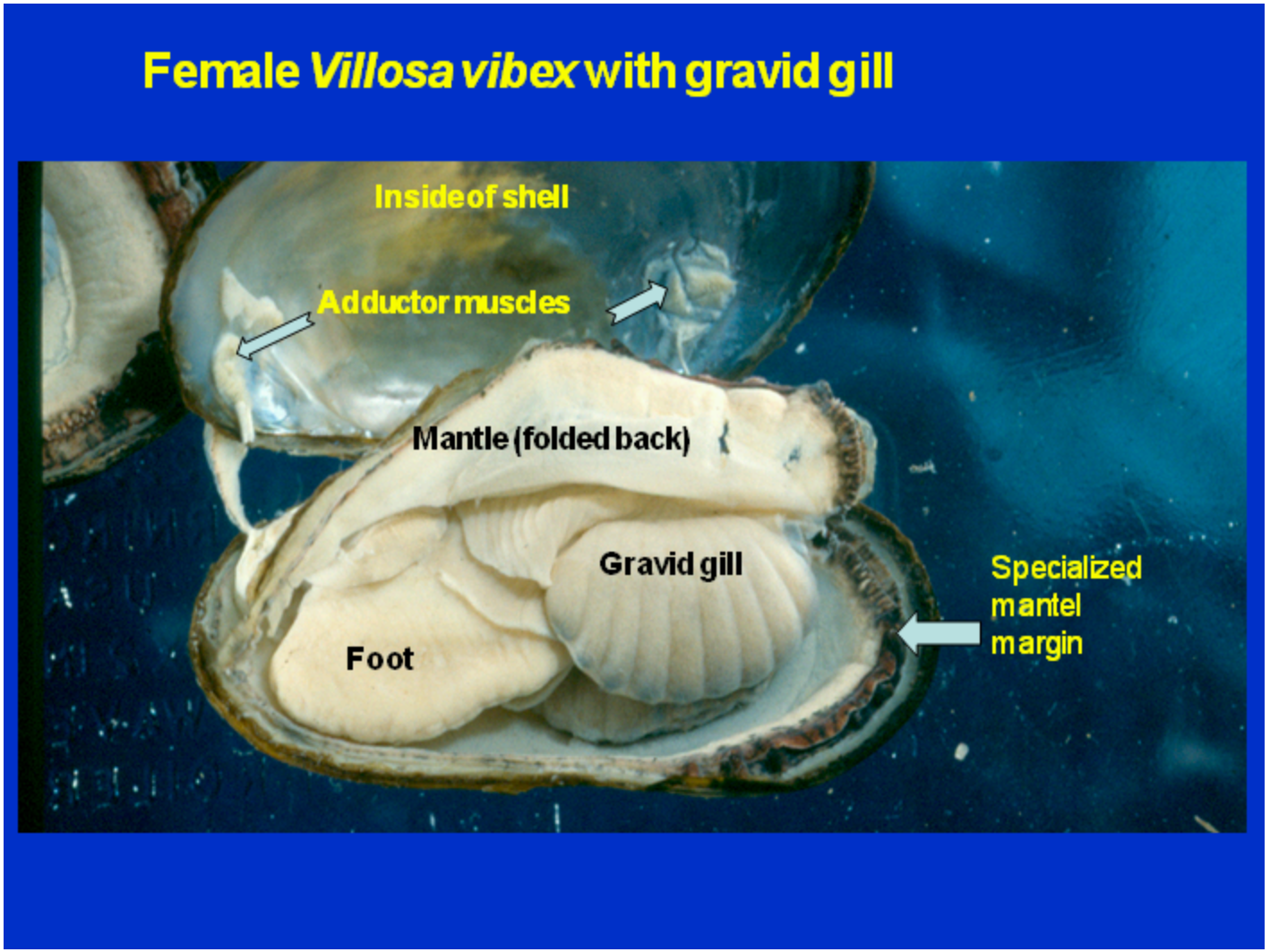
# Fertilization

- Male freshwater mussels release sperm into the water colu

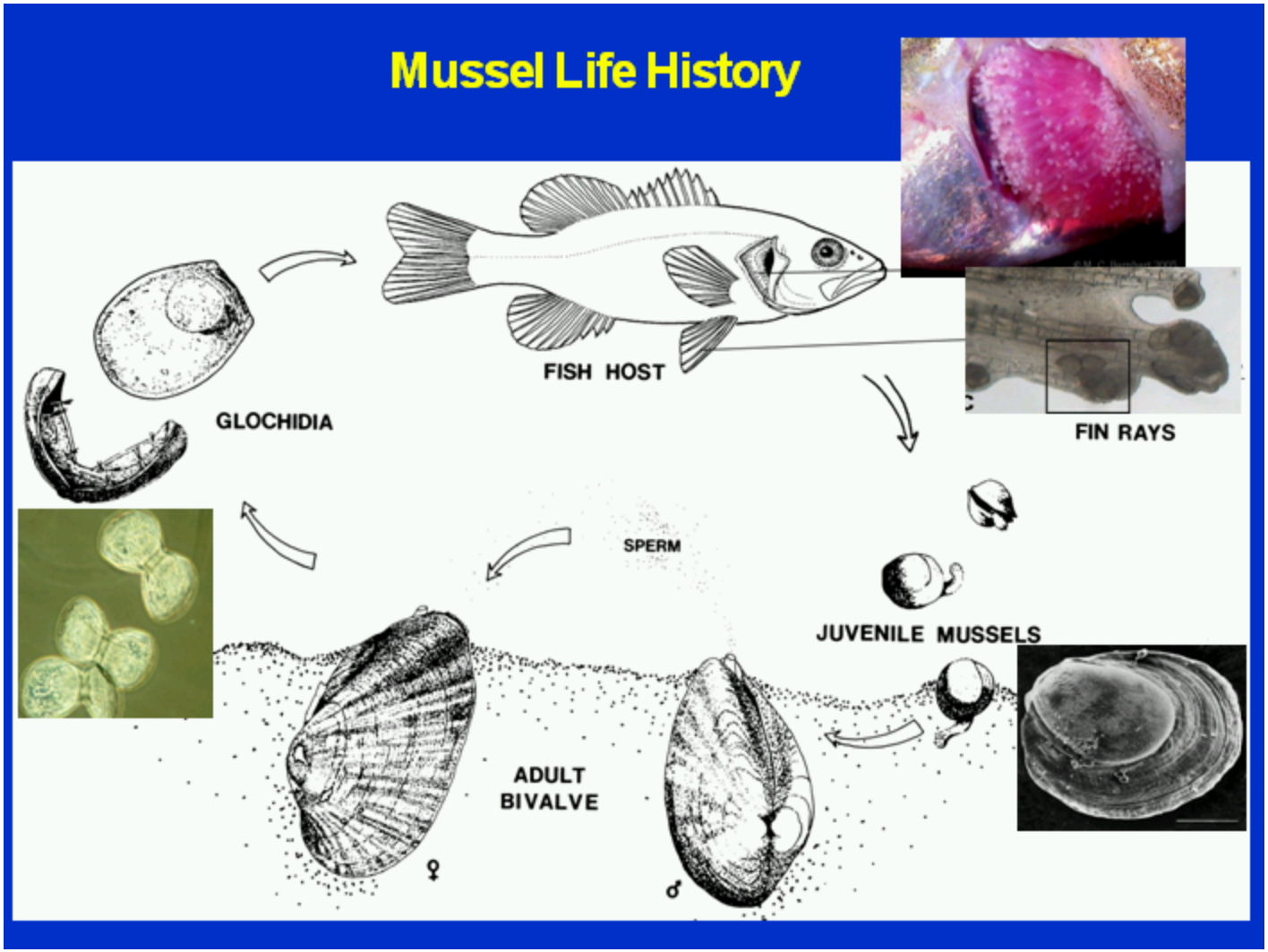
- It is taken in by the female via the incurrent aperture.

- Fertilization occurs internally, apparently in the suprabranchial chamber as ova are passed from the gonad to the marsupia (modified water tubes in gill).

Slide 11


Female *Villosa vibex* with gravid gill
Inside of shell
Adductor muscles
Mantle (folded back)
Gravid gill
Specialized mantel margin
Foot

Slide 12


Mussel Life History
FISH HOST
FIN RAYS
GLOCHIDIA
SPERM
JUVENILE MUSSELS
ADULT
BIVALVE
♀
♂

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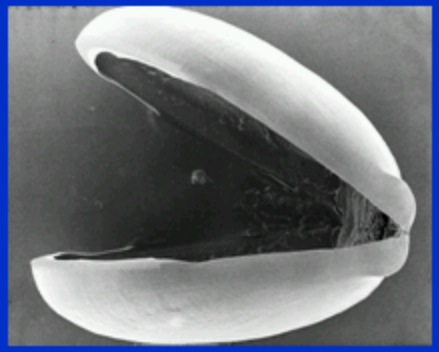
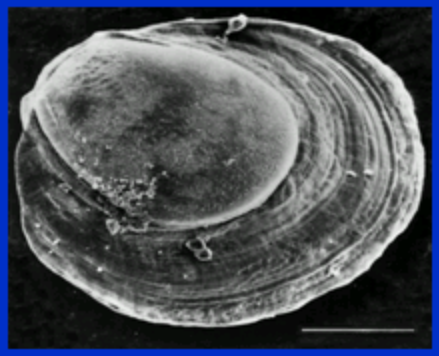
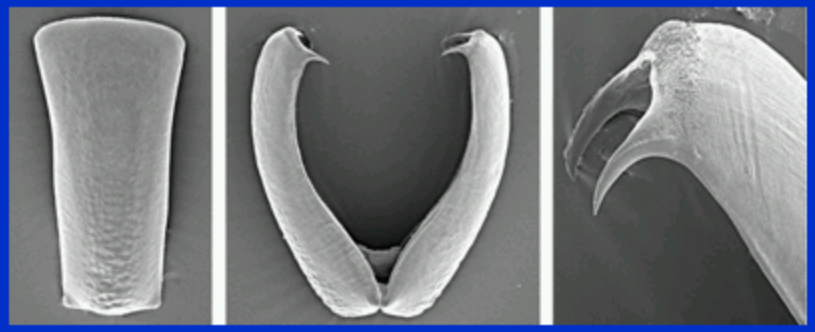
# Glochidia Structure

- Individual glochidia are small (range 1/10 to 1/3 mm in length)
- Glochidia are often "packaged" into conglutinates





Juvenile 21 days post-excystment



Number of glochidia per female range from a few thousand to over 300 thousand

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# Looking for a few good fishes....

Villosa iris ↑

Villosa vibex ↑

Gravid Females
Displaying

Lampsilis cardium ⟶

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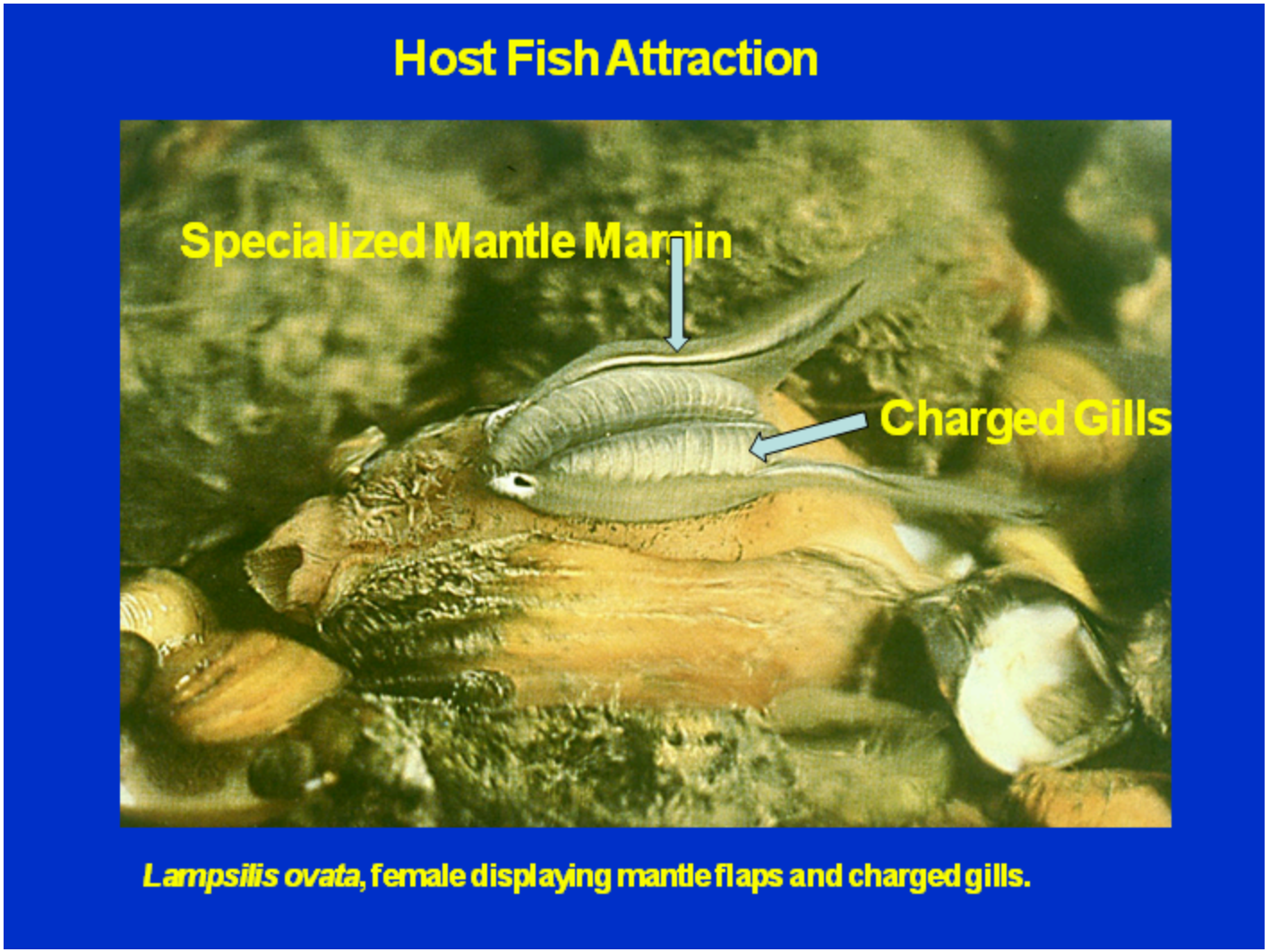
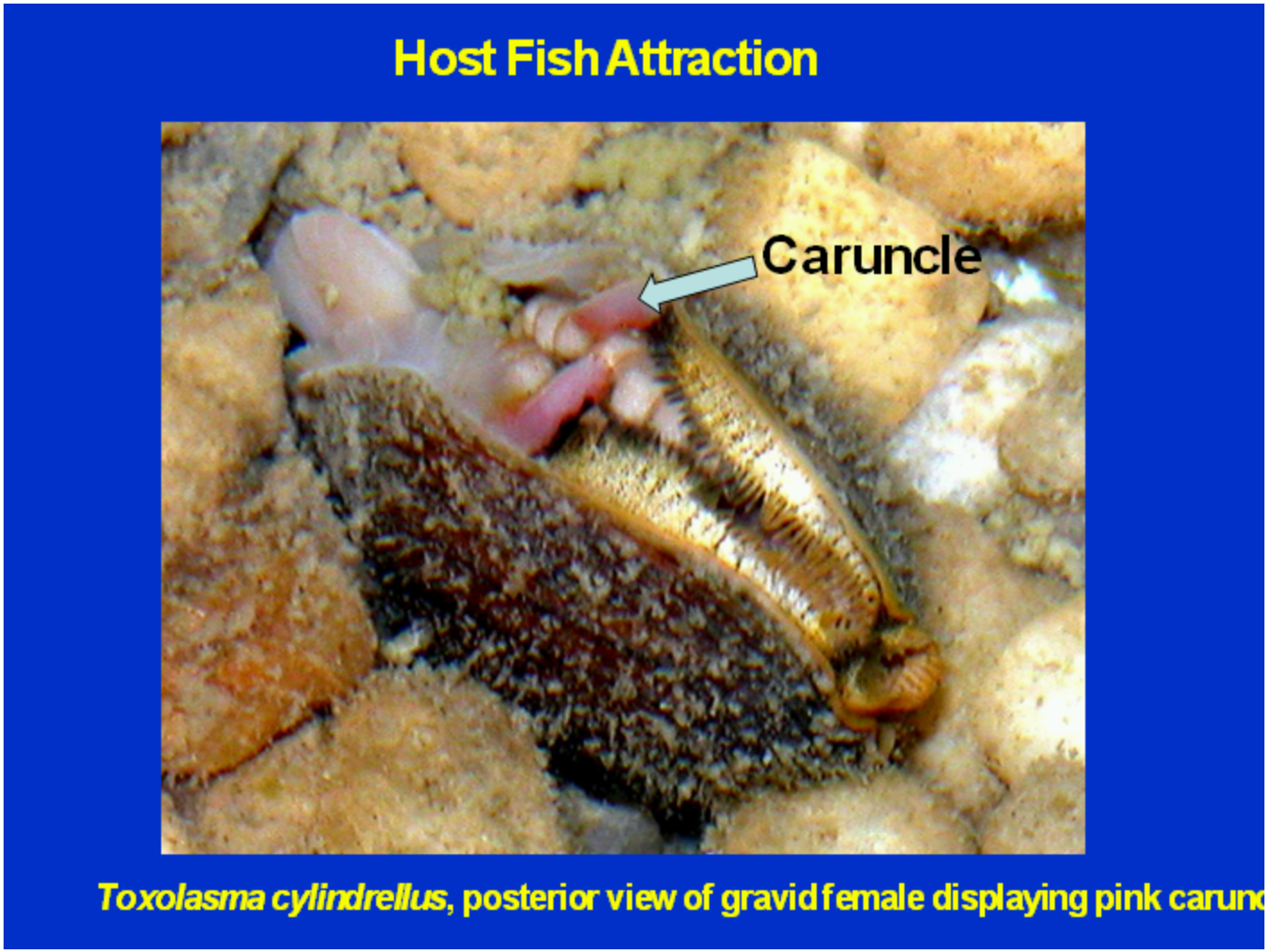
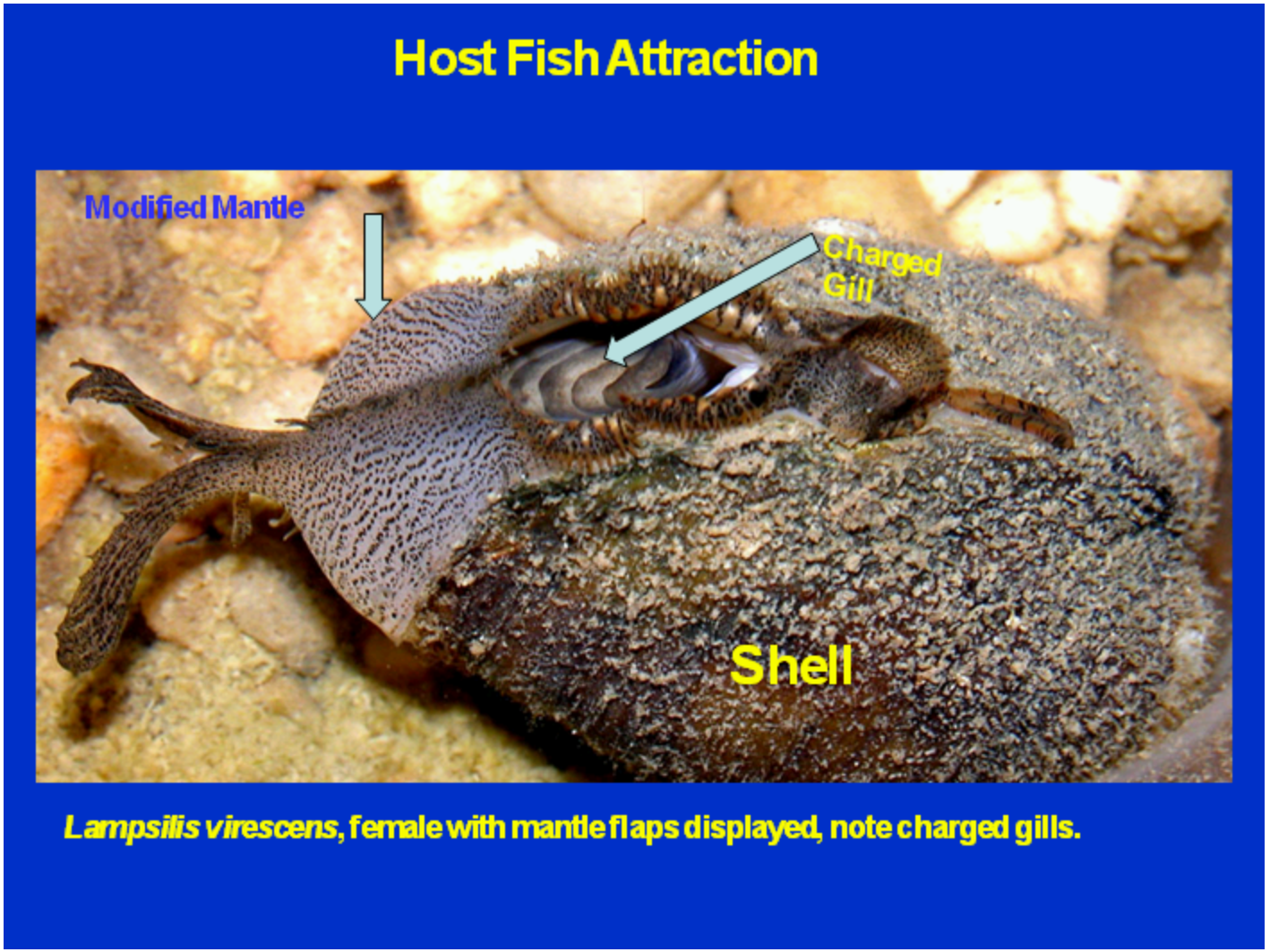

Host Fish Attraction
Specialized Mantle Margin
Charged Gills
*Lampsilis ovata*, female displaying mantle flaps and charged gills.

Slide 16


Host Fish Attraction
Caruncle
*Toxolasma cylindrellus*, posterior view of gravid female displaying pink carunc

Slide 17


Host Fish Attraction
Modified Mantle
Charged Gill
Shell
*Lampsilis virescens*, female with mantle flaps displayed, note charged gills.

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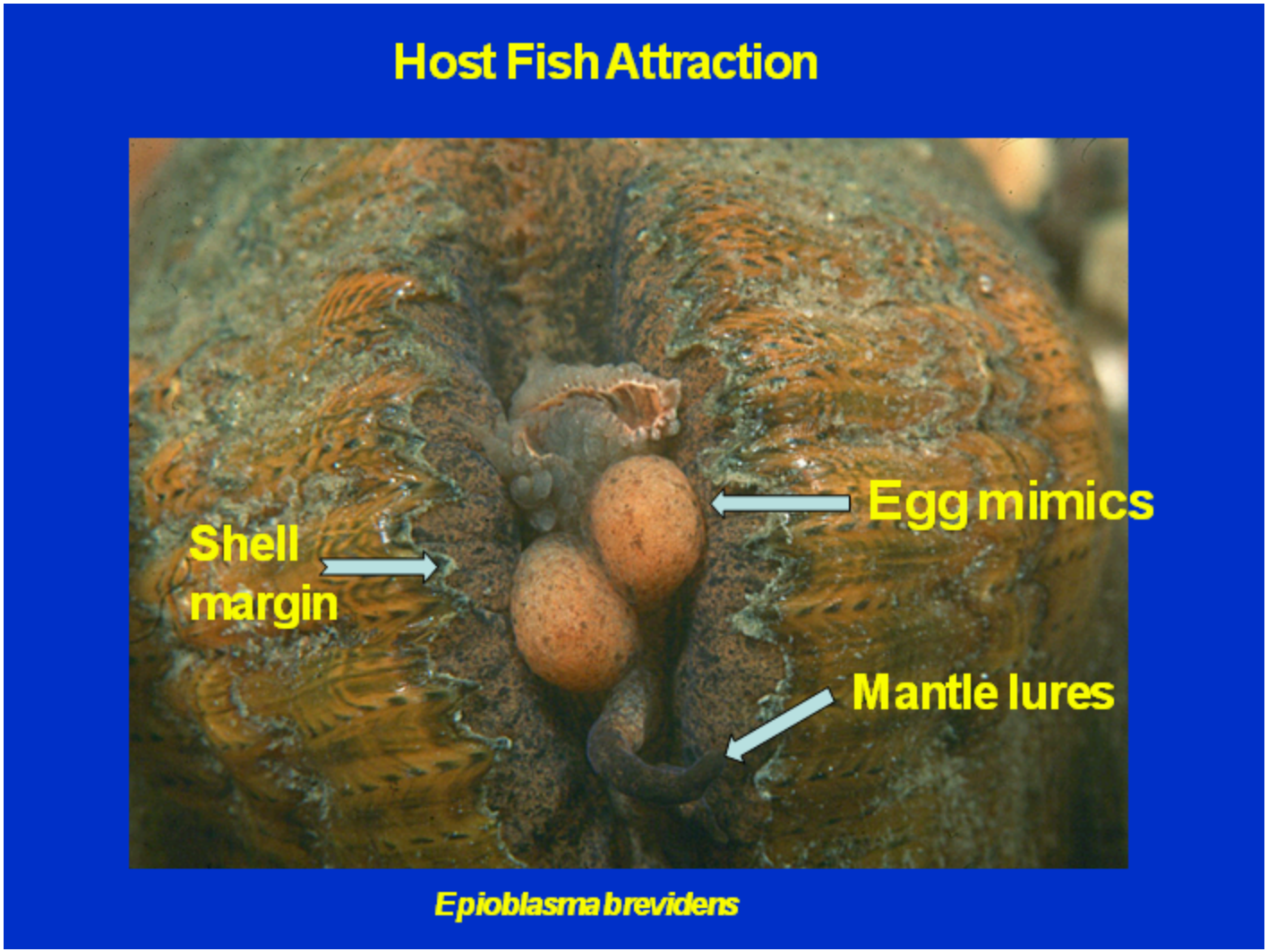
Host Fish Attraction
Egg mimics
Shell margin
Mantle lures
Epioblasma brevidens

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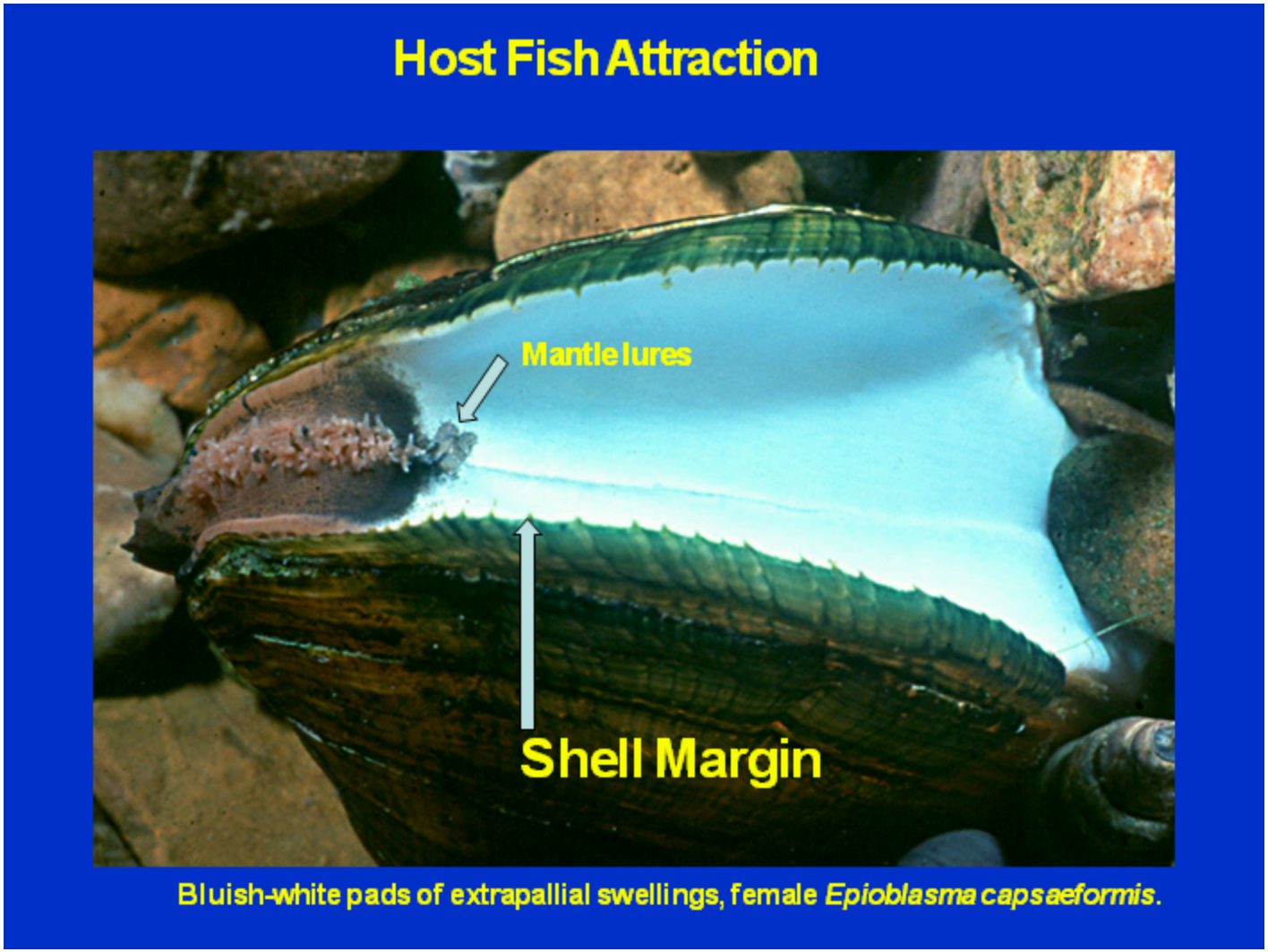
Host Fish Attraction
Mantle lures
Shell Margin
Bluish-white pads of extrapallial swellings, female *Epioblasma capsaeformis*.

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## Host Fish Attraction

Bluish-white mantle pads of female *Epioblasma capsaeformis*


Logperch with snout caught between valves of *Epioblasma triquetra*

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# Packaging of Glochidia

*Ptychobranchus fasciolaris*
conglutinates mimic larval fish

*Ptychobranchus subtentum*
conglutinates mimic larval stage of an insect

Conglutinates of
*Dromus dromas*
mimic flatwormes?

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## Host Fish Attraction

***Hamiota perovalis*, stages of superconglutinate discharge.**

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## Host Fish Attraction

***Hamiota subangulata*** **in an artificial stream, discharging a superconglutinate.**

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Search for Mussel/Host Relationships
Ohio State University Museum – Host Fish Database
You may search any or all of the following fields. Enter as much information as you know. If you do not find any results the first time, try a less specific search.
contains
Mussel
Family:
Subfamily:
Scientific name (genus and/or species):
Host
Family:
Scientific name (genus and/or species):
Common name:
Other
Citation:
Continent:
THE OHIO STATE UNIVERSITY
DIVISION OF MOLLUSCS
http://www.biosci.ohio-state.edu/~molluscs/OSUM2/

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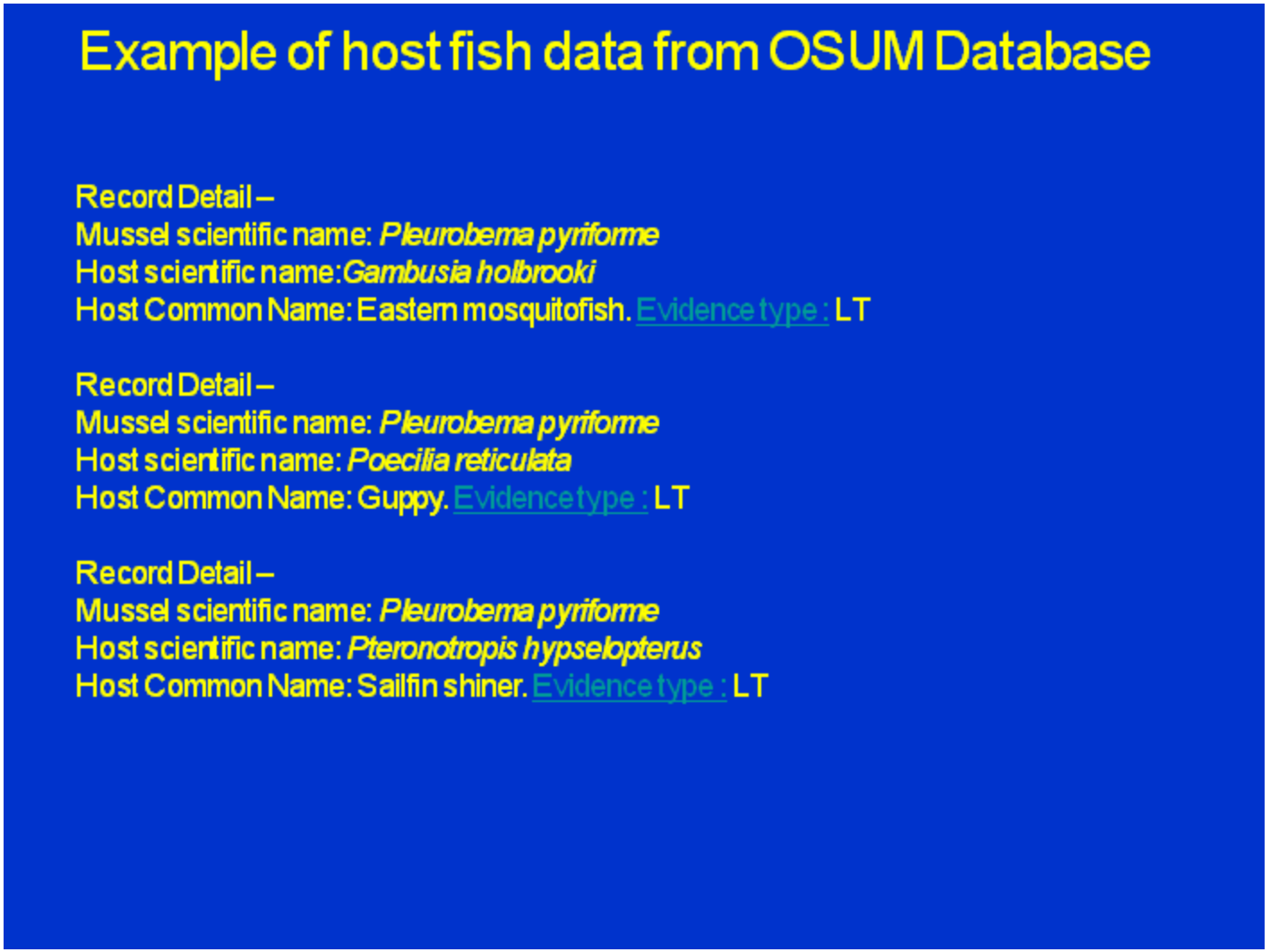
Example of host fish data from OSUM Database
Record Detail –
Mussel scientific name: Pleurobema pyriforme
Host scientific name: Gambusia holbrooki
Host Common Name: Eastern mosquitofish. Evidence type : LT
Record Detail –
Mussel scientific name: Pleurobema pyriforme
Host scientific name: Poecilia reticulata
Host Common Name: Guppy. Evidence type : LT
Record Detail –
Mussel scientific name: Pleurobema pyriforme
Host scientific name: Pteronotropis hypselopterus
Host Common Name: Sailfin shiner. Evidence type : LT

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Commercial Mussel Harvest
Mussel brail boat, Tombigbee River, Alabama
Brail hooks used in the harvest of mussels

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## Brail hooks used in the harvest of mussels

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## Mussels attached to crowfoot brail hooks

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Slide 30


Slide 31


Slide 32

# Production of Cultured Pearls

- Cubes of mussel shell (upper left) used in production of rounded nuclei or "seed pearls" ready for insertion into a pearl oyster to produce a cultured pearl.

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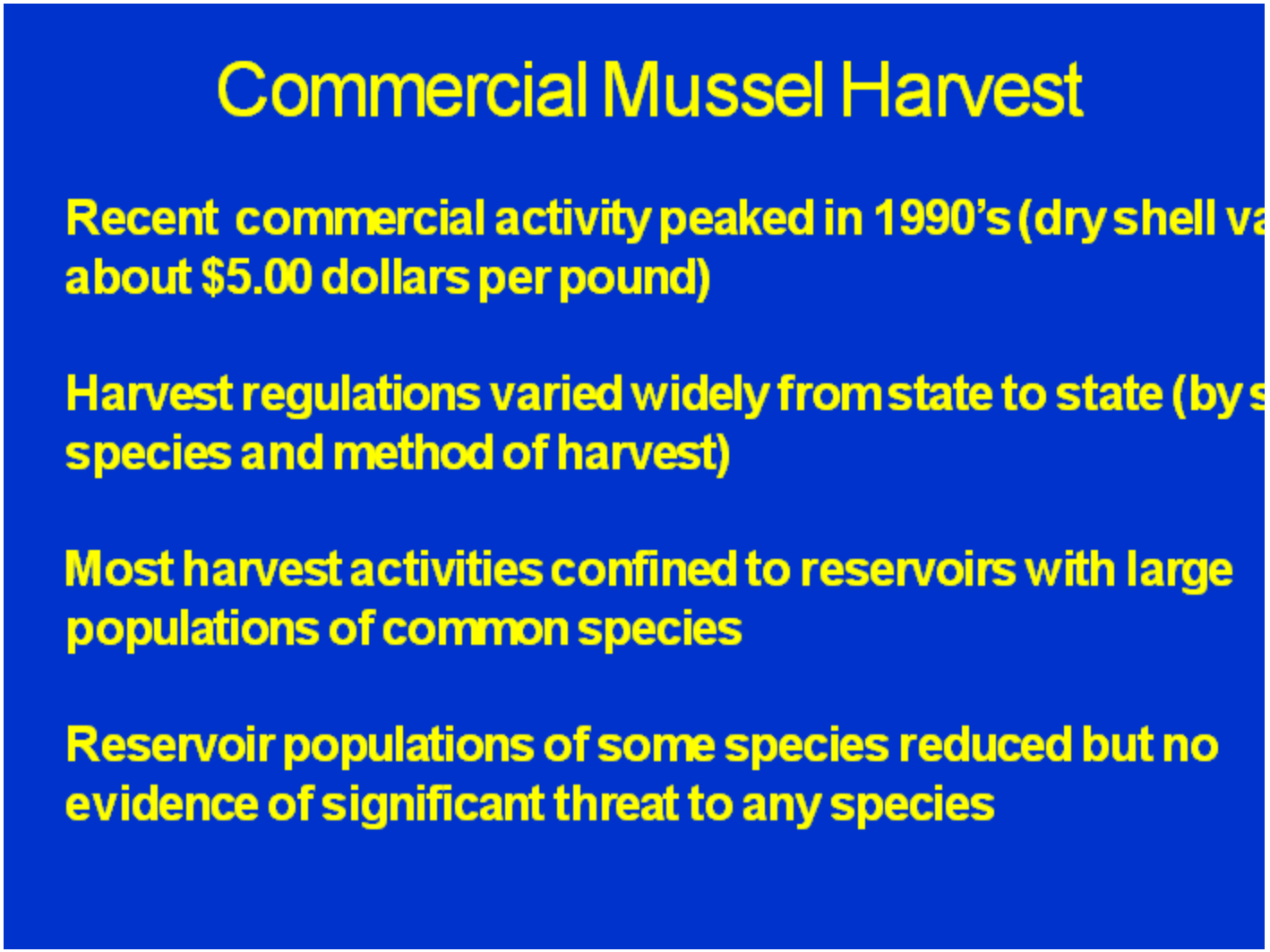
Commercial Mussel Harvest
Recent commercial activity peaked in 1990's (dry shell va
about $5.00 dollars per pound)
Harvest regulations varied widely from state to state (by s
species and method of harvest)
Most harvest activities confined to reservoirs with large
populations of common species
Reservoir populations of some species reduced but no
evidence of significant threat to any species

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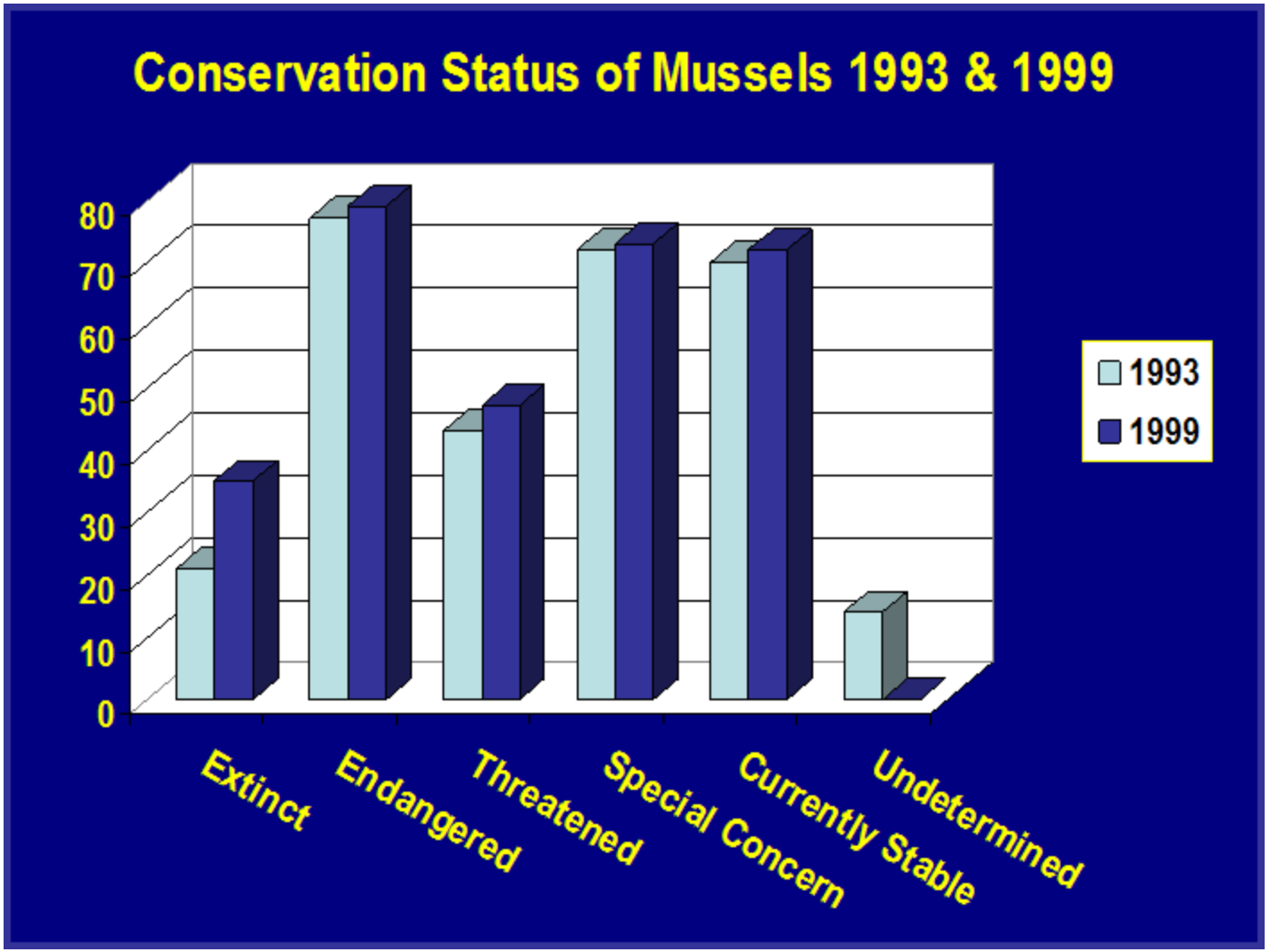
Conservation Status of Mussels 1993 & 1999
80
70
60
50
40
30
20
10
0
1993
1999
Extinct
Endangered
Threatened
Special Concern
Currently Stable
Undetermined

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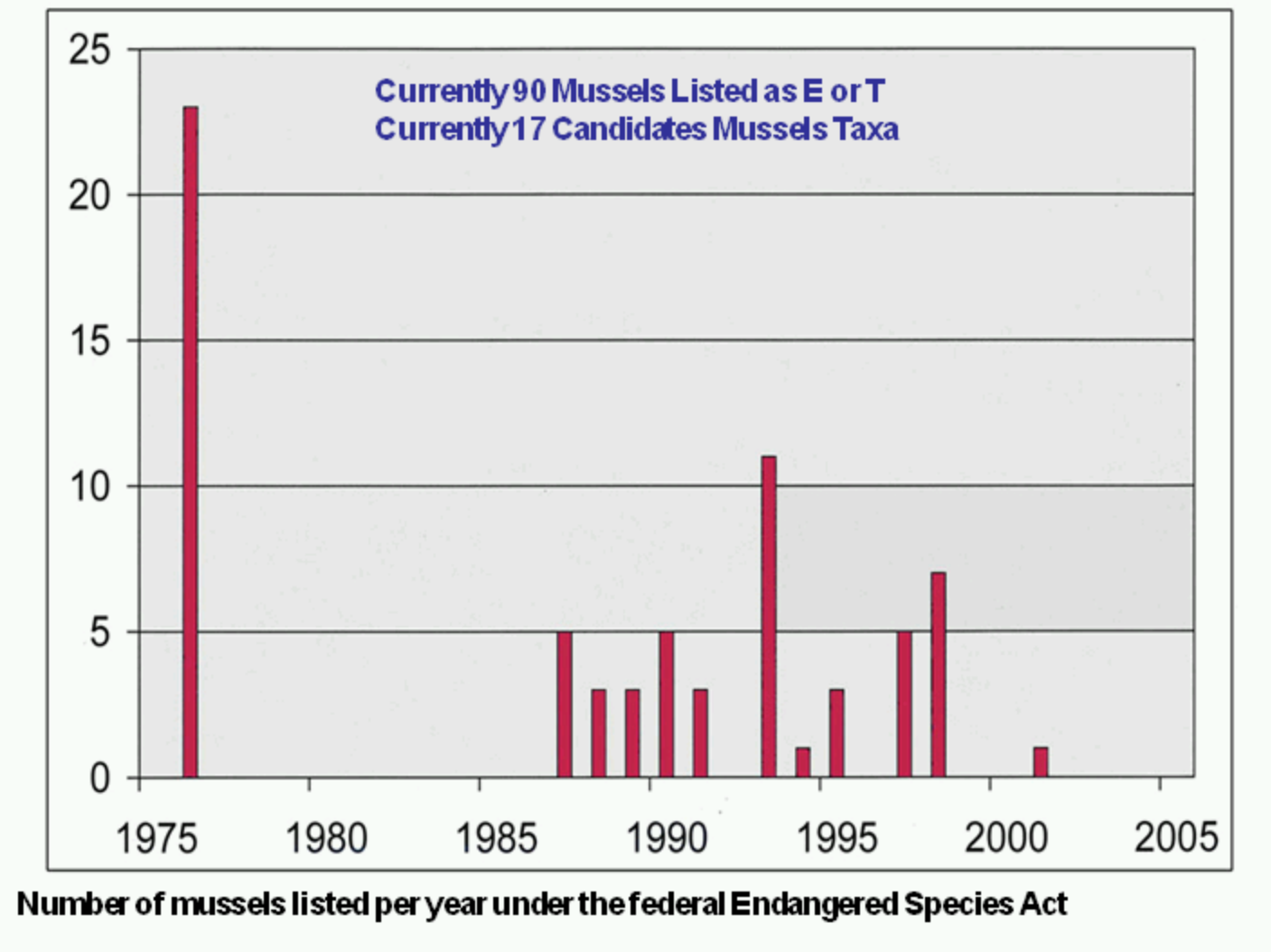
Currently 90 Mussels Listed as E or T
Currently 17 Candidates Mussels Taxa
25
20
15
10
5
0
1975
1980
1985
1990
1995
2000
2005
Number of mussels listed per year under the federal Endangered Species Act

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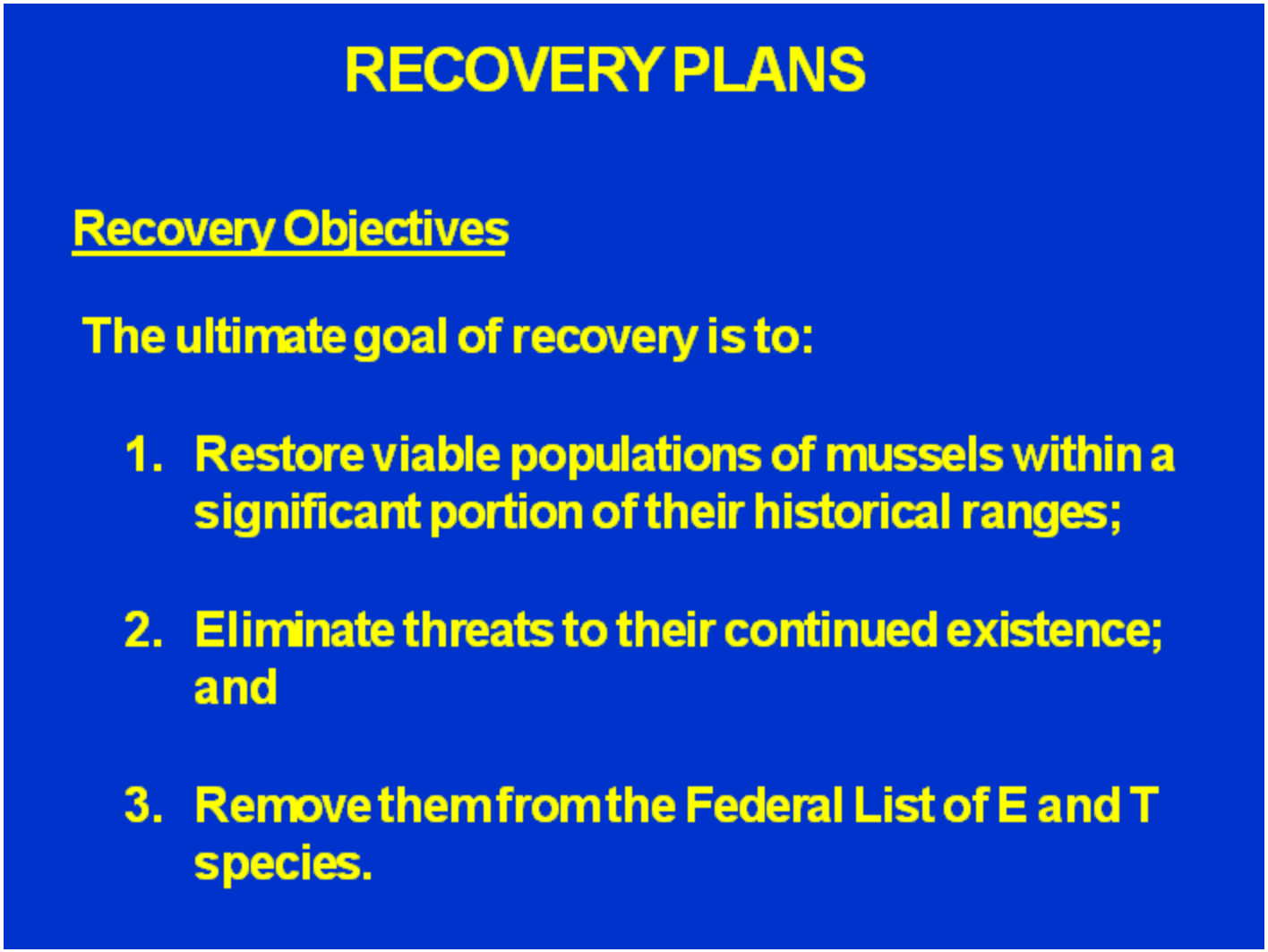
RECOVERY PLANS
Recovery Objectives
The ultimate goal of recovery is to:
1. Restore viable populations of mussels within a significant portion of their historical ranges;
2. Eliminate threats to their continued existence; and
3. Remove them from the Federal List of E and T species.

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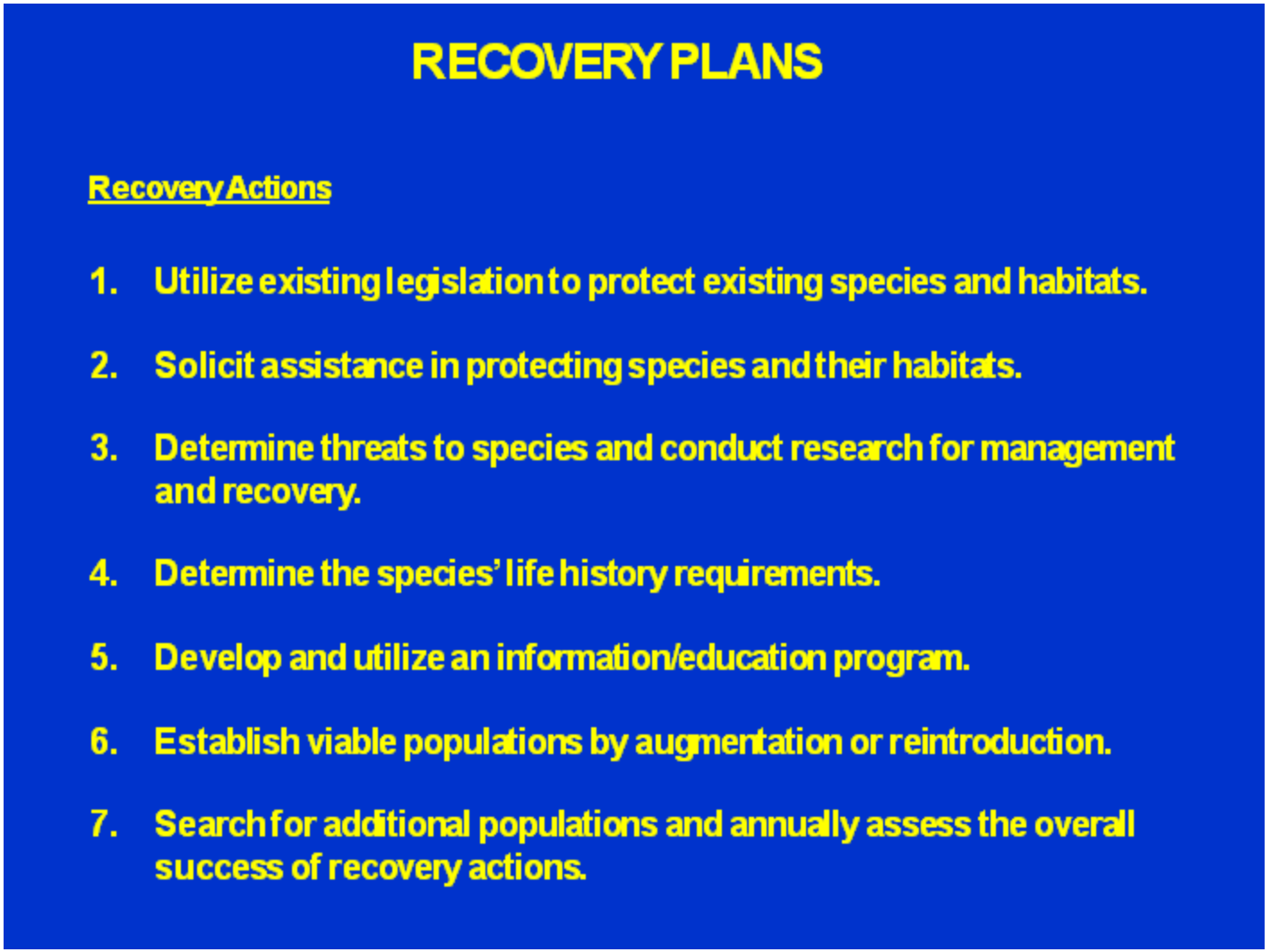
RECOVERY PLANS
Recovery Actions
1. Utilize existing legislation to protect existing species and habitats.
2. Solicit assistance in protecting species and their habitats.
3. Determine threats to species and conduct research for management and recovery.
4. Determine the species' life history requirements.
5. Develop and utilize an information/education program.
6. Establish viable populations by augmentation or reintroduction.
7. Search for additional populations and annually assess the overall success of recovery actions.

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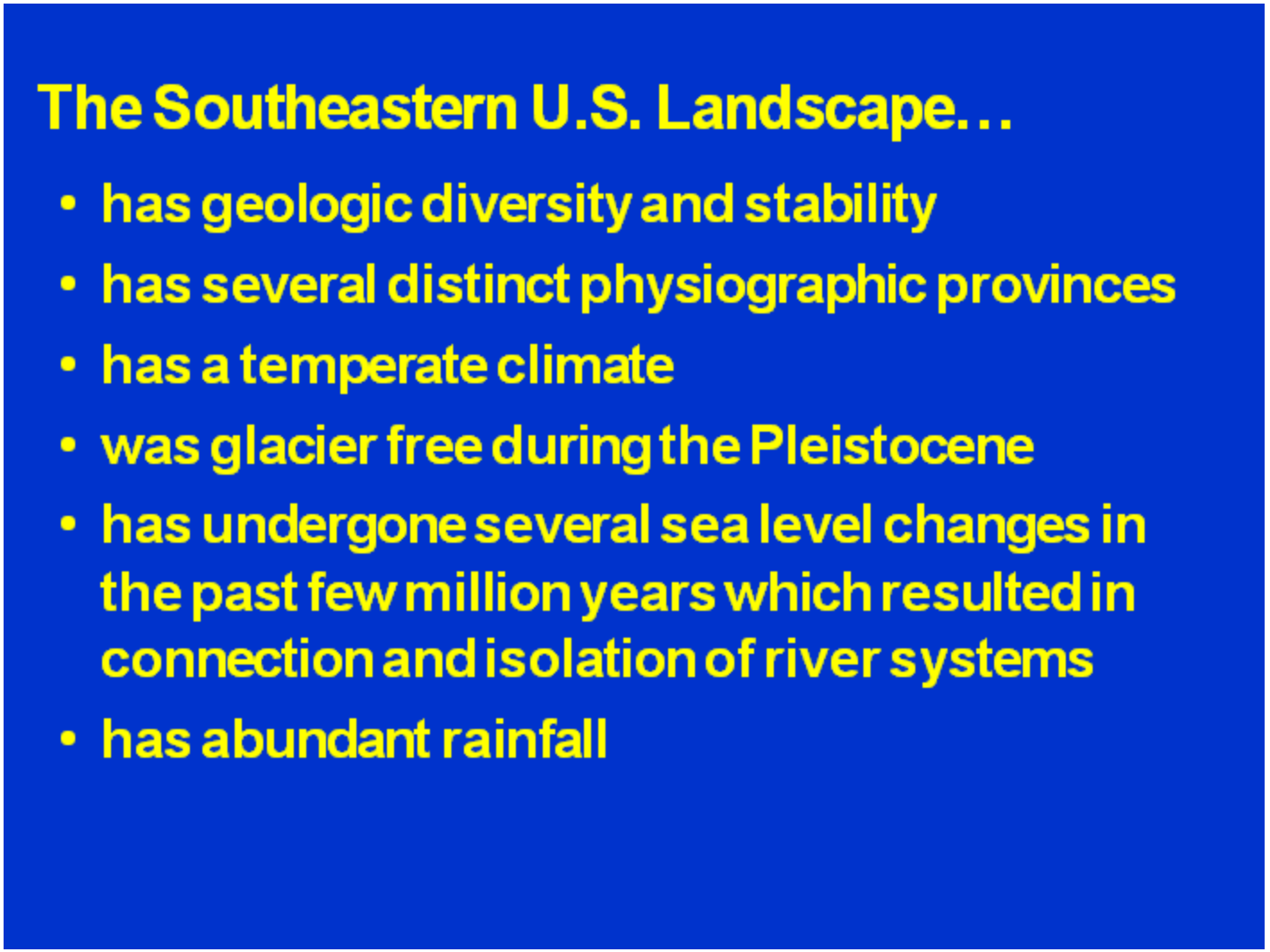
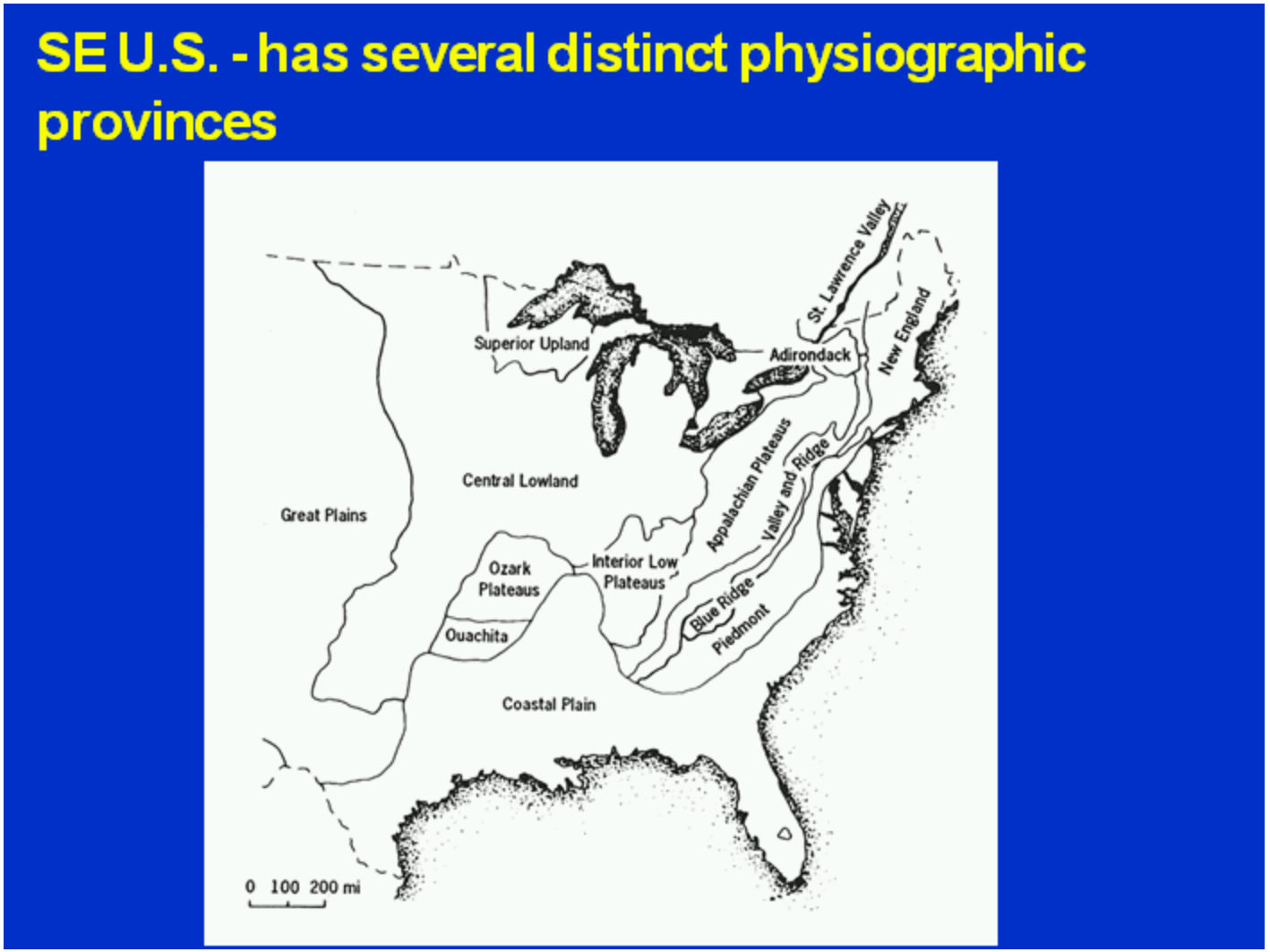
Southeastern Mussel Fauna




The Southeastern U.S. Landscape…

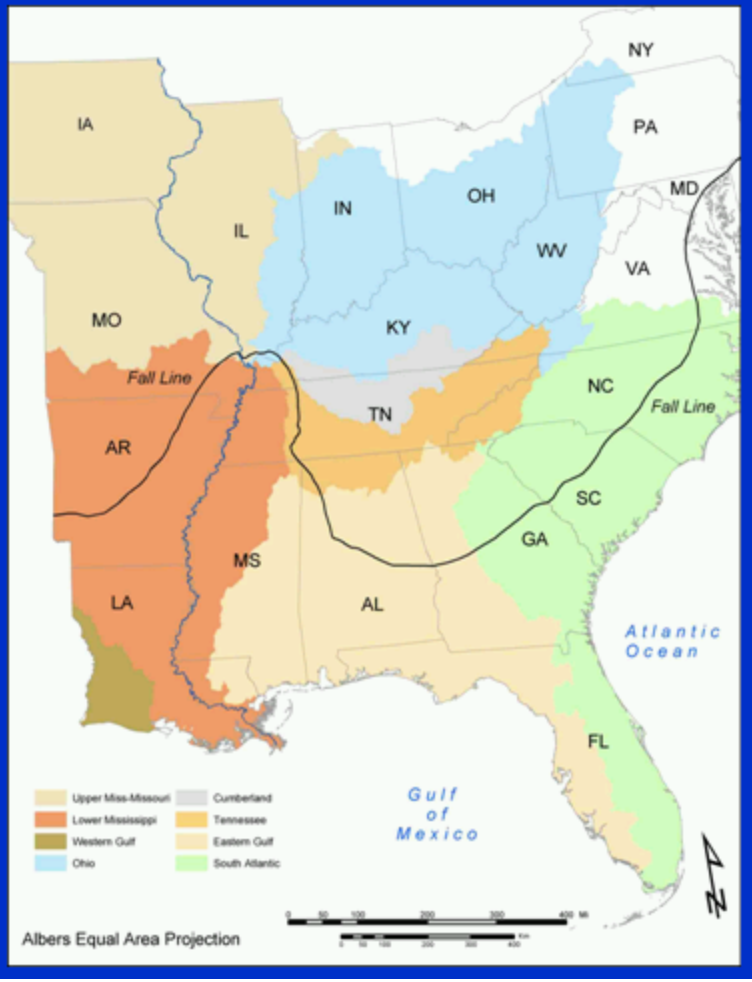



SE U.S. - has several distinct physiographic provinces

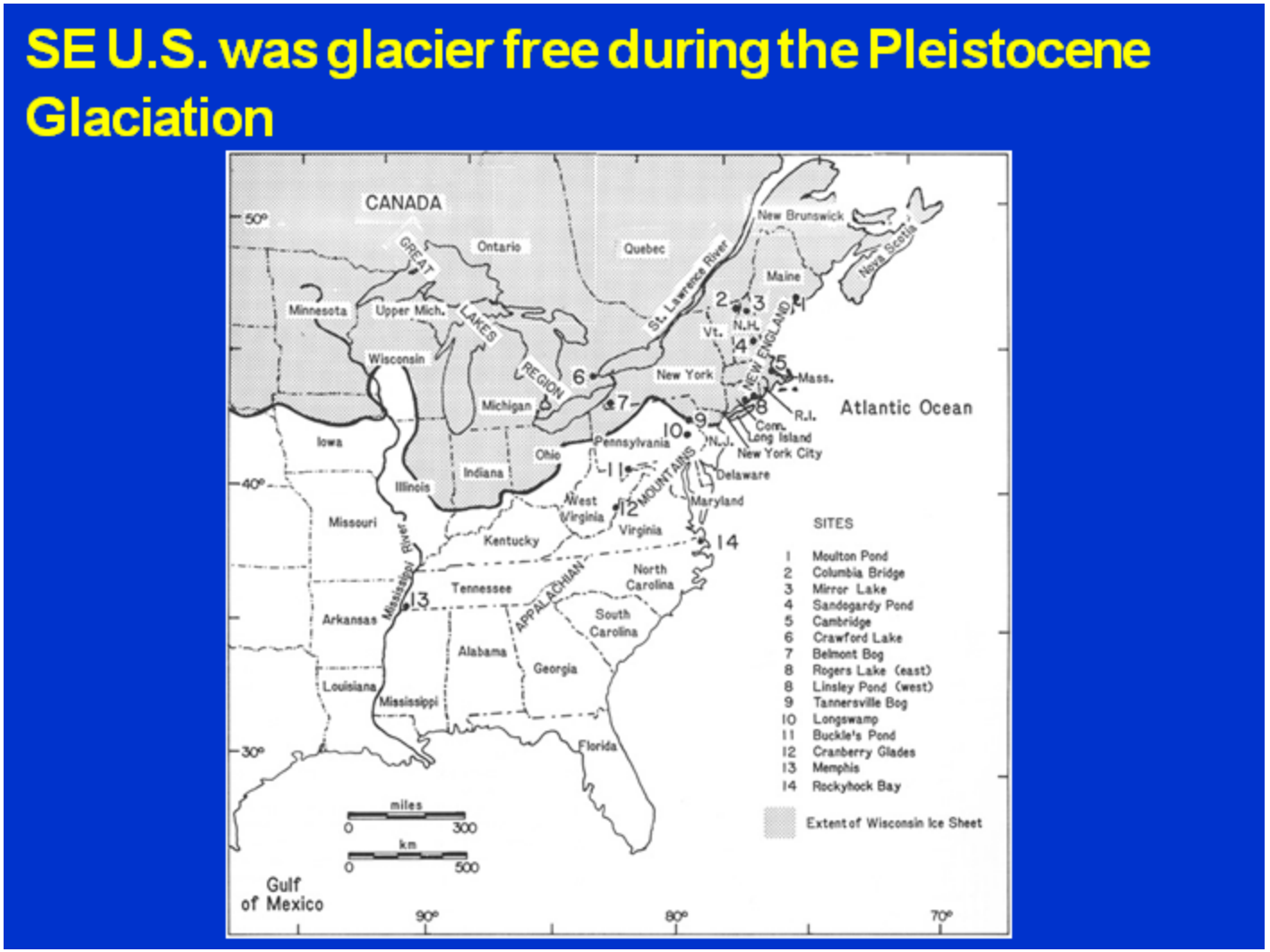
# Fall Line – Inner Margin of Coastal Plain

**Fall Line** – the boundary between the Coastal Plain and upland physiographic provinces along the Atlantic and Gulf of Mexico coasts of eastern North America.

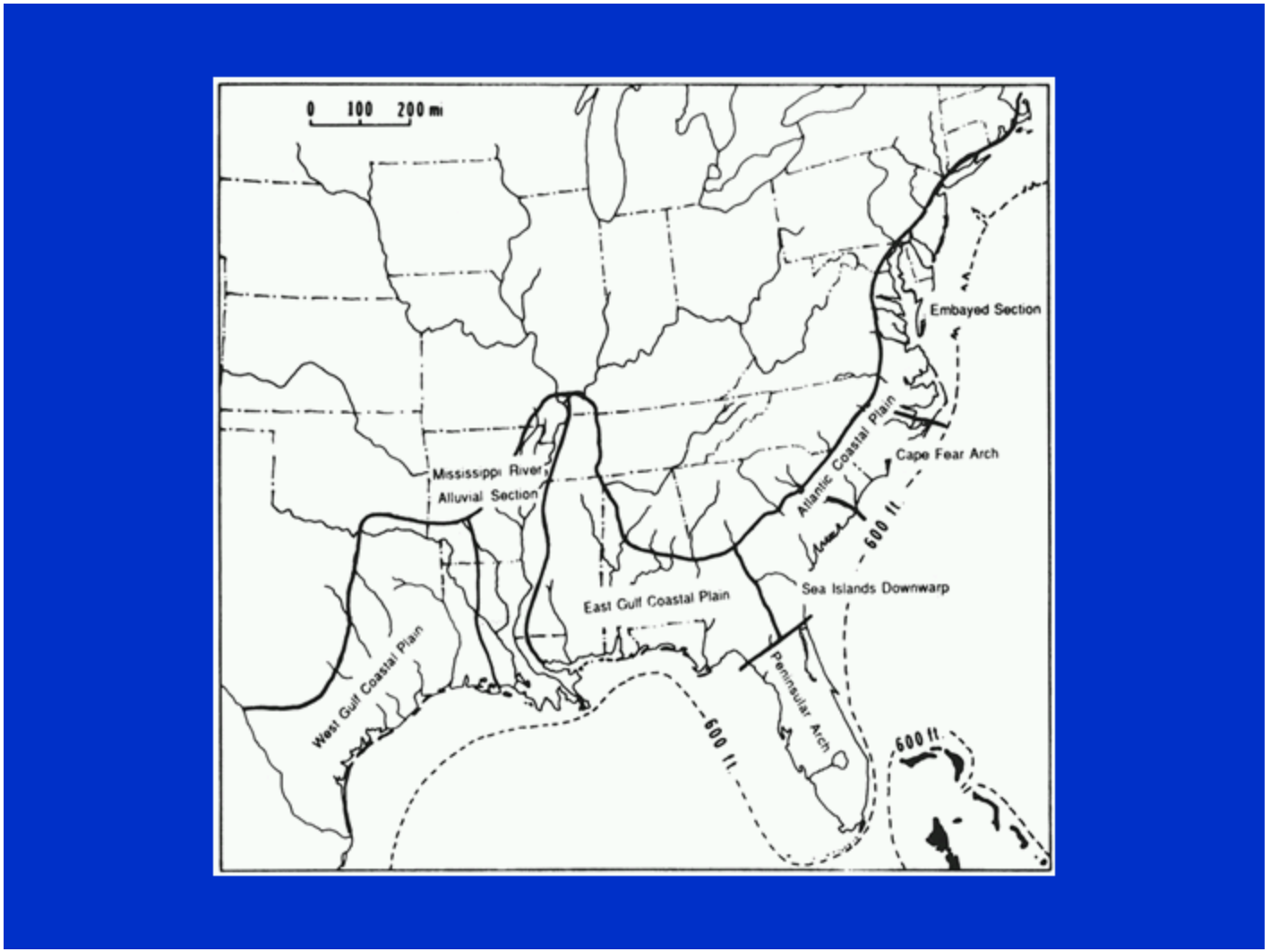
**Streams crossing the Fall Line experience an abrupt change in**
- **geology**
- **substrate**
- **decreased gradient**
- **channel morphology**
- **slight increase in streamtemp**
- **slight change in water chemistry**




Fall Line – Inner Margin of Coastal Plain




SE U.S. was glacier free during the Pleistocene Glaciation


0 100 200 mi
Embayed Section
Atlantic Coastal Plain
Cape Fear Arch
600 ft
Mississippi River
Alluvial Section
East Gulf Coastal Plain
Sea Islands Downwarp
West Gulf Coastal Plain
Peninsular Arch
600 ft
600 ft

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THREATS TO AQUATIC DIVERSITY
** URBANIZATION OF WATERSHEDS & STORMWATER RUNOFF (impervious surfaces)
** LARGE DAMS ON RIVERS (impoundments above and channel incision downstream)
** SMALL IMPOUNDMENTS ON CREEKS (farm ponds)
** CHANNELIZATION OF STREAMS (unstable substrate)
* MINING ACTIVITIES
* POLLUTION BY CHEMICAL CONTAMINANTS
* RIPARIAN DEVELOPMENT (floodplain development)
* AGRICULTURE & SILVACULTURE (sediment and agricultural chemicals)
** NONINDIGENOUS AQUATIC SPECIES

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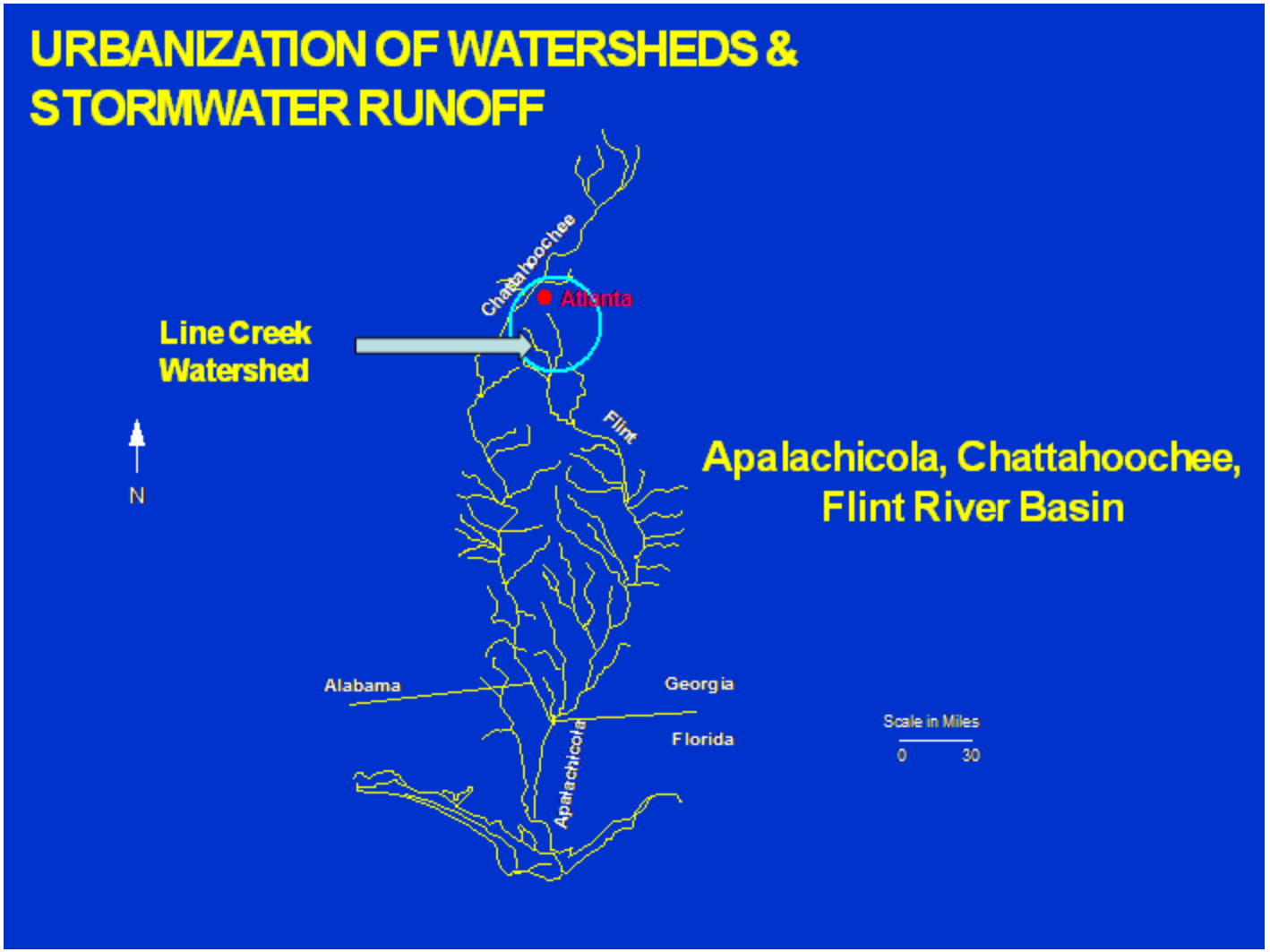
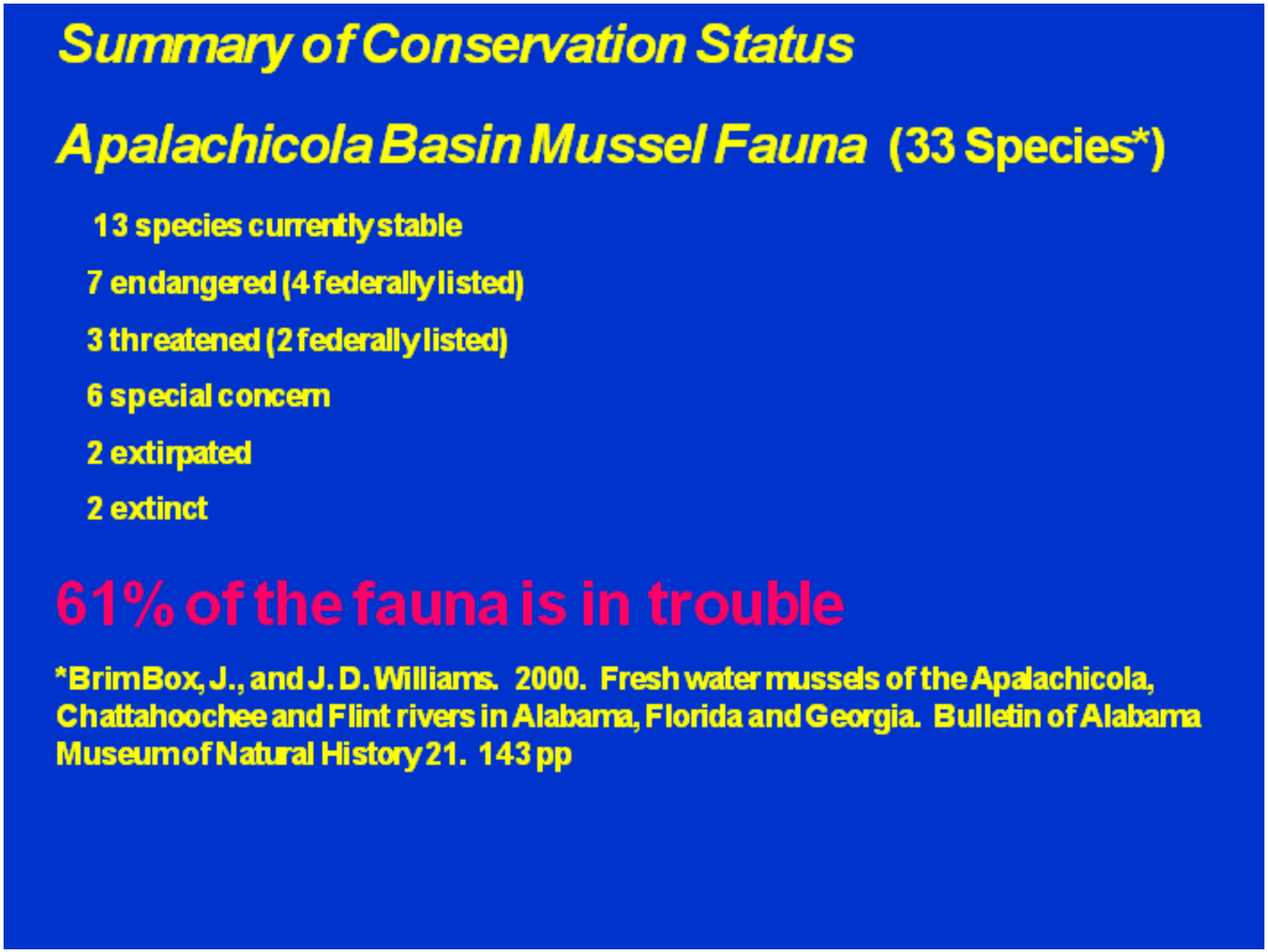



Apalachicola, Chattahoochee,  Flint River Basin


Summary of Conservation Status
Apalachicola Basin Mussel Fauna (33 Species*)
13 species currently stable
7 endangered (4 federally listed)
3 threatened (2 federally listed)
6 special concern
2 extirpated
2 extinct
61% of the fauna is in trouble
*BrimBox, J., and J. D. Williams. 2000. Fresh water mussels of the Apalachicola, Chattahoochee and Flint rivers in Alabama, Florida and Georgia. Bulletin of Alabama Museum of Natural History 21. 143 pp

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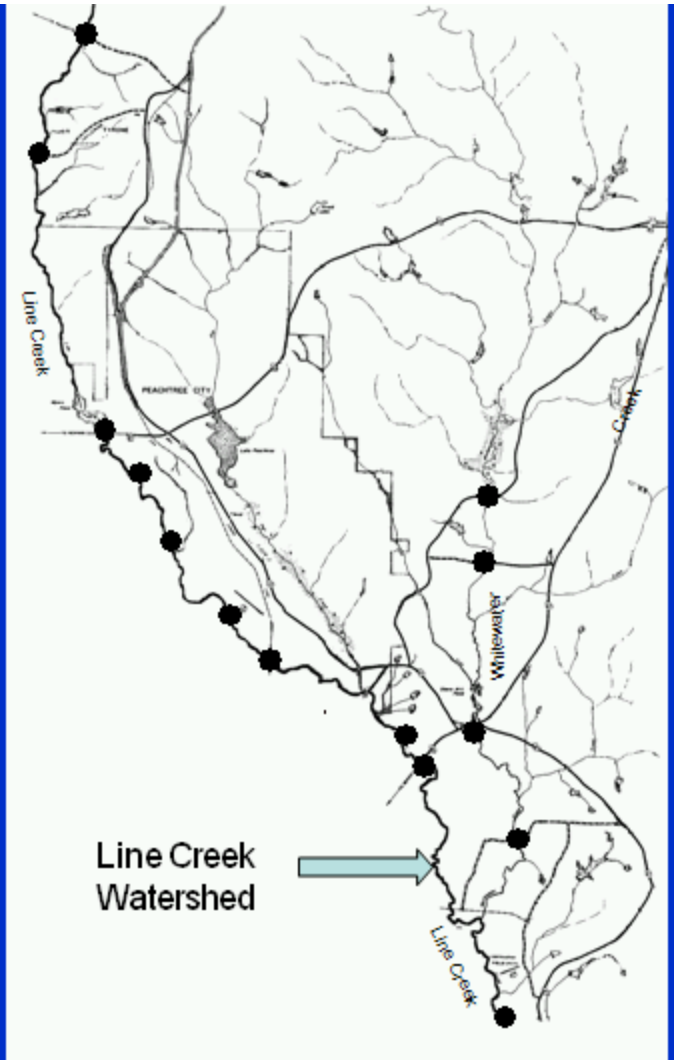
**Line Creek near Peachtree City, Fayette & Coweta Counties, Georgia**

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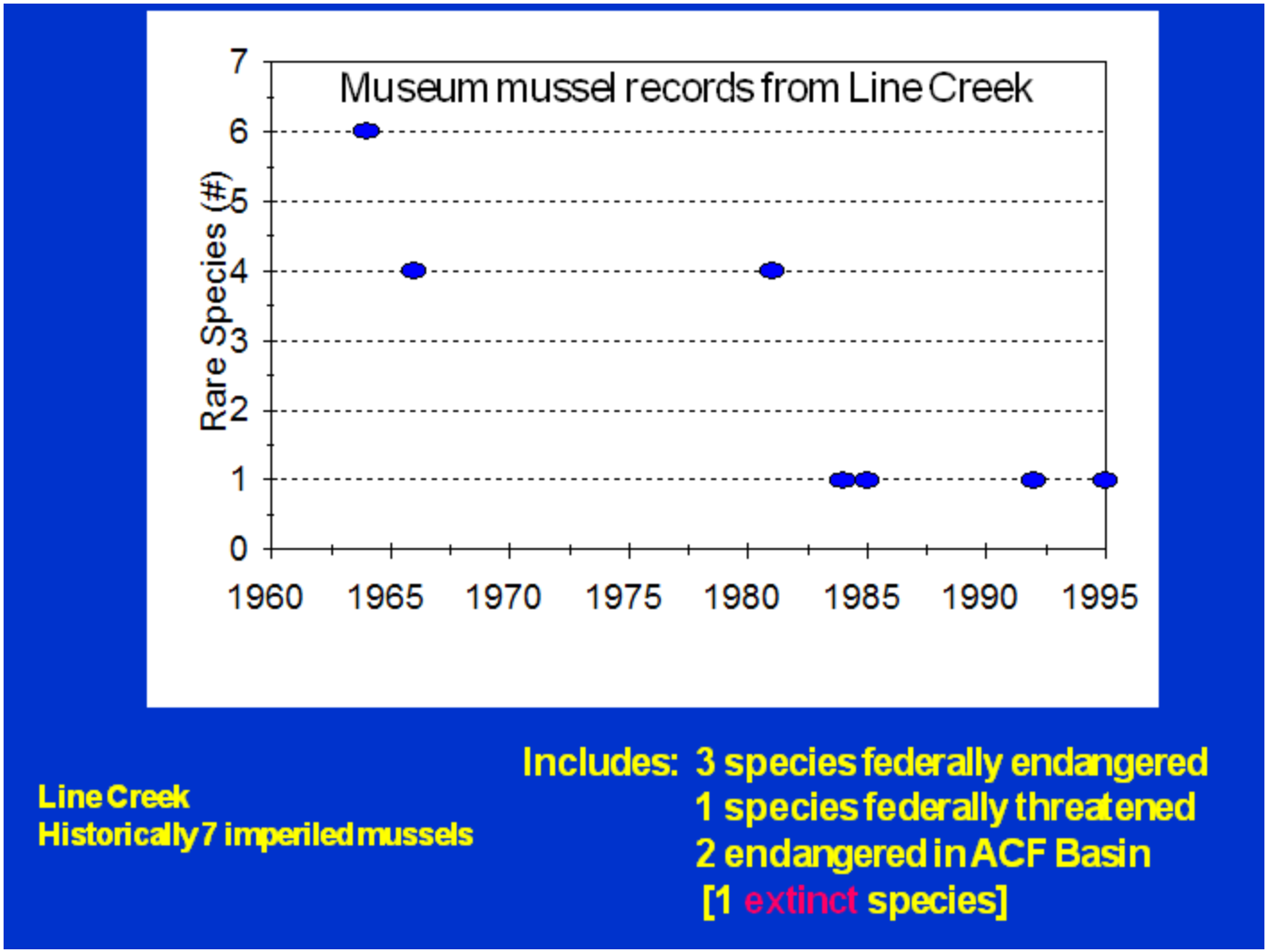
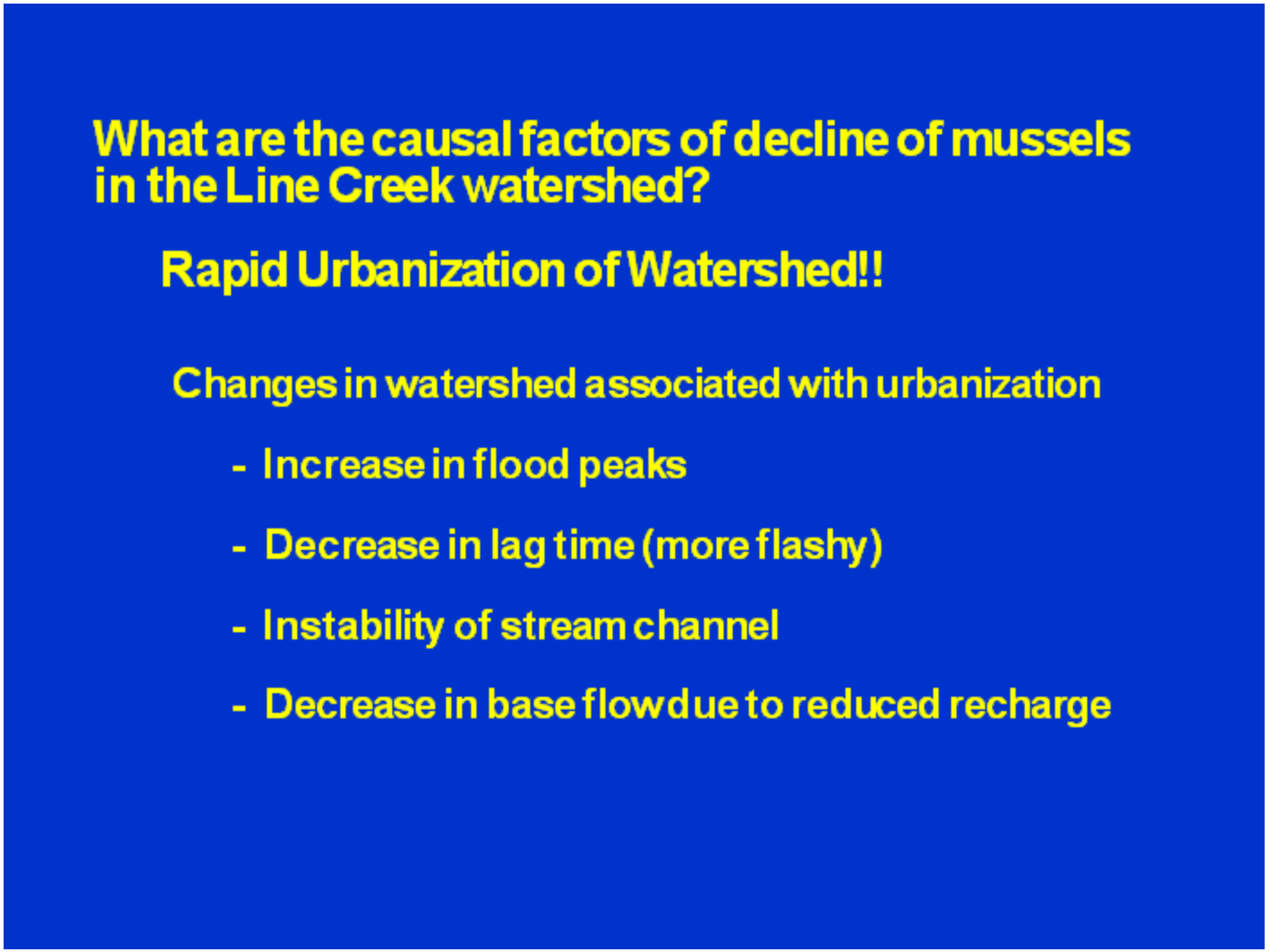



Museum mussel records from Line Creek


What are the causal factors of decline of mussels in the Line Creek watershed?
Rapid Urbanization of Watershed!!
Changes in watershed associated with urbanization
- Increase in flood peaks
- Decrease in lag time (more flashy)
- Instability of stream channel
- Decrease in base flow due to reduced recharge

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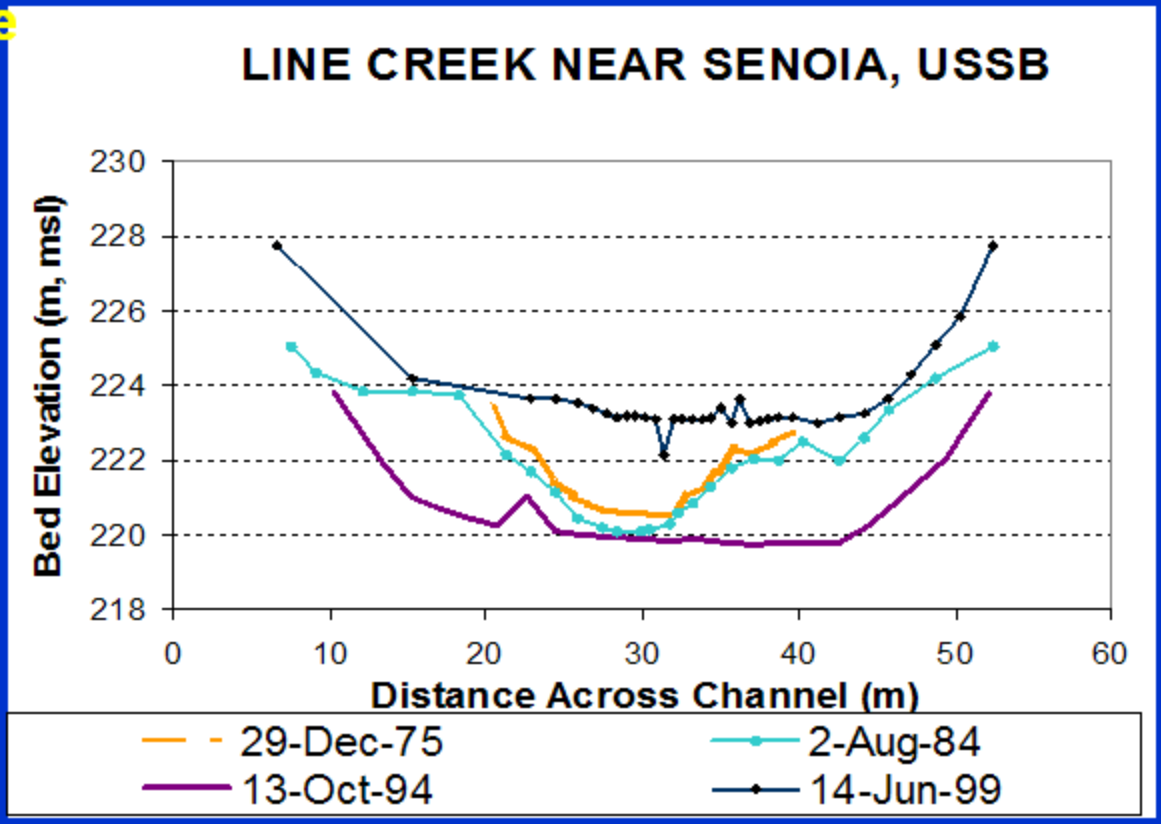
# Analysis of Cross Section Data & Stream Discharge Over Time




Effects of urbanization on the aquatic fauna of the Line Creek watershed, Atlanta—a satellite perspective

Robert R. Gilliesa, Jayne Brim Box, Jurgen Symanzikc and Eli J. Rodemaker

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# LARGE DAMS ON RIVERS

Jim Woodruff Dam on Apalachicola River

**Restoration of Rivers...**
**Via Dam Removal**

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JIM'S TOP 10 DAMS TO CONSIDER
FOR REMOVAL FOR RIVER RESTORATION
IN ALABAMA, FLORIDA, AND GEORGIA
1. Jim Woodruff Dam
Apalachicola River, FL, AL & GA
2. George Andrews Dam
Chattahoochee River, AL & GA
3. Claiborne Dam
Alabama River, AL
4. Millers Ferry Dam
Alabama River, AL
5. Jones Bluff Dam
Alabama River, AL
6. Gainesville Dam
Tombigbee River, AL
7. Pickensville Dam
Tombigbee River, AL
8. Point A Dam
Conecuh River, AL
9. Gantt Dam
Conecuh River, AL
10. Albany Dam
Flint River, GA

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FACTORS TO CONSIDER
IN RECOMMENDING DAMS FOR REMOVAL
Current use or purpose of structure
Owner/operator of structure
Age of structure
Degree of difficulty to remove
Cost of removal and restoration
Can a functioning riverine ecosystem be restored
How many miles or river/creek can be recovered
How many T & E species would benefit
Will migratory fish runs be restored
Value of restored recreational opportunities

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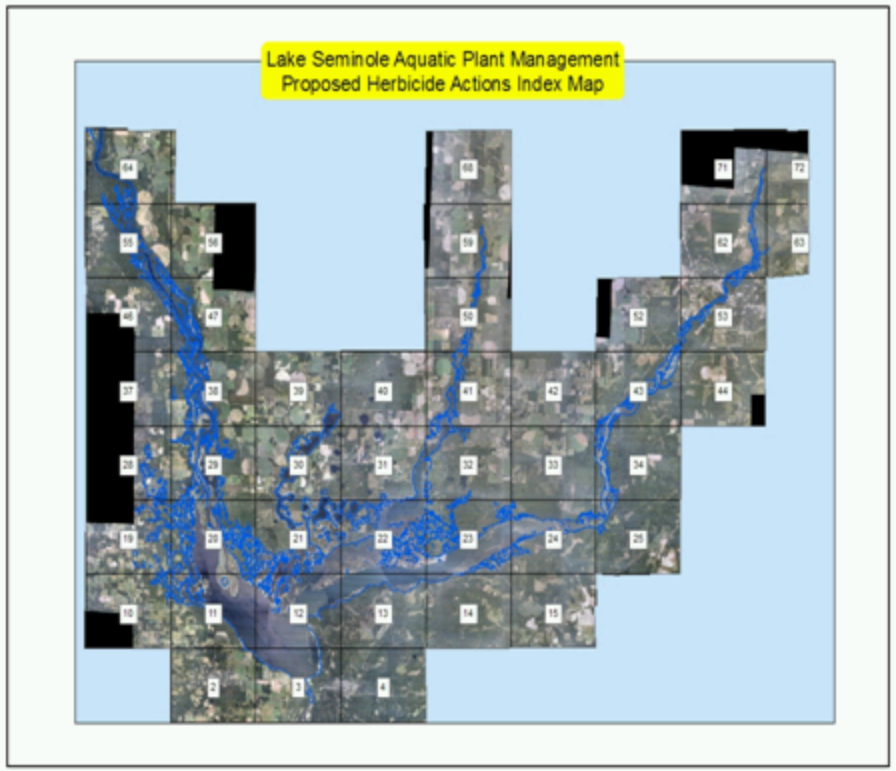
# Jim Woodruff Dam
# Seminole Reservoir FL, AL and GA

Water Area (acres)37,500
Land Area (acres)22,000
Shoreline (miles)376




**Impoundment Length**
Chattahoochee R. 30 mi.
Flint R. 35 mi.
Tributaries @40 mi.

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## Jim Woodruff Dam Florida


1. **Use or purpose of dam** – *Navigation, Power, Recreation*
2. **Owner/operator of structure** – *U.S. Corps of Engineers*
3. **Age of structure** – *50 years old (life expectancy @ 100 years)*
4. **Degree of difficulty to remove** – *Easy to moderately difficult*

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Apalachicola River,
Florida
Near River mile 48

6. Can a functioning riverine ecosystem be restored – *Yes*
7. How many miles or river can be recovered – *65 to 105 miles*
8. How many T & E species would benefit – *6 species (5 mussels & 1 fish)*
9. Will migratory fish runs be restored – *Yes (Gulf Sturgeon, Striped Bass, Alabama Shad and Skipjack Herring)*
10. Value of restored recreational opportunities – $$

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Economic Arguments
against river restoration/dam removal
1. Loss of power production and navigation.
(Loss of hydro power is small but real)
(Loss of navigation would be a savings)
2. Who would pay for the cost of dam removal
(U.S. Government would pay but within 20 years would actually save money)
3. Marina developments and fishing opportunities would suffer
(Reservoir fishing would be lost but river fishing would be restored)
( New hunting opportunities in the newly created 65 K acre Tristate WMA)
4. Property values of lake shore development would decline
(So would their taxes)
(If dam not removed then let property owners pay dam O&M cost)

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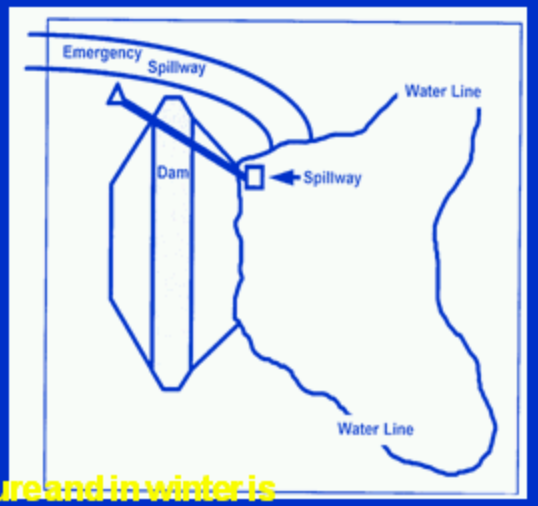
# Farm ponds




Vary widely in size and purpose

Most employ a "stand pipe" configuration for the outlet. Water skimmed from the surface and falls into a pipe or culvert for release below the dam

Problems...
Water skimmed in summer is elevated in temperature and in winter is cooler than unimpounded streams

Channel downstream of dam is usually entrenched (one to several feet)

Partial solution ... a multi level outlet structure (reduces temperature problem)

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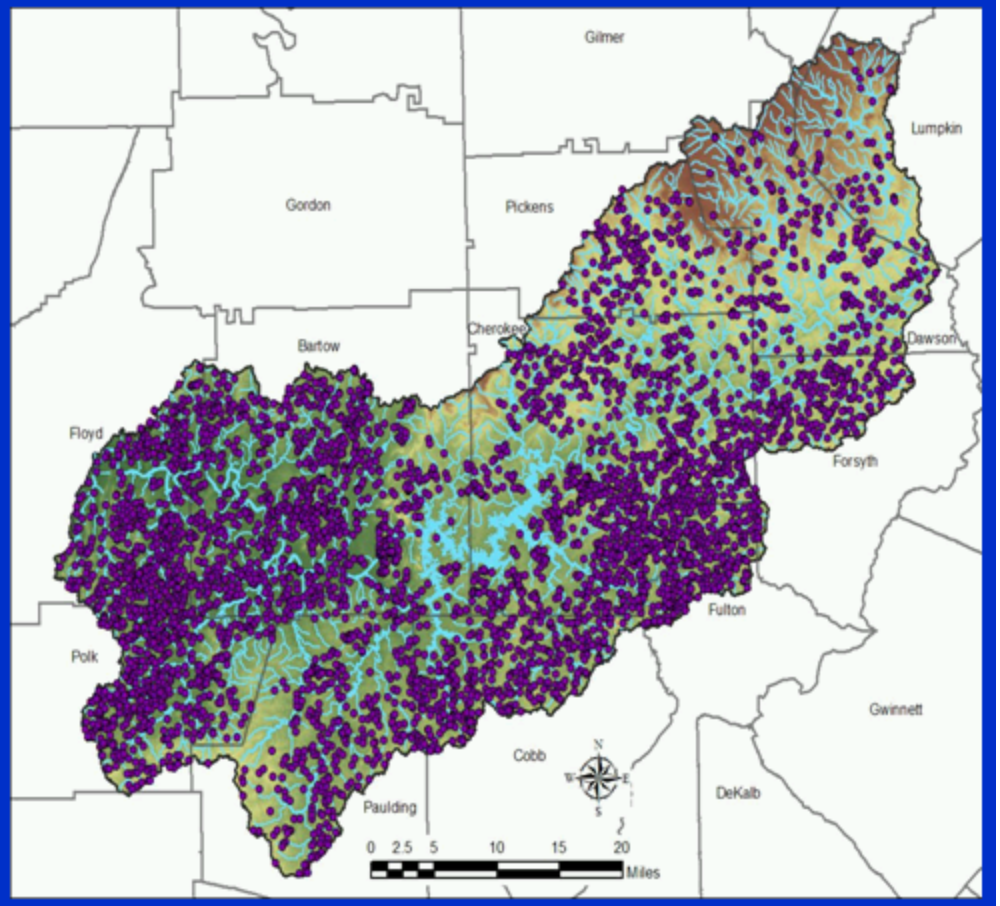
**Etowah River Drainage**

**Farm Ponds**

**PURPLE DOTS a total 4680 "impoundments" These include all bodies of water which appear to be man-made with dam less than 50 feet high**

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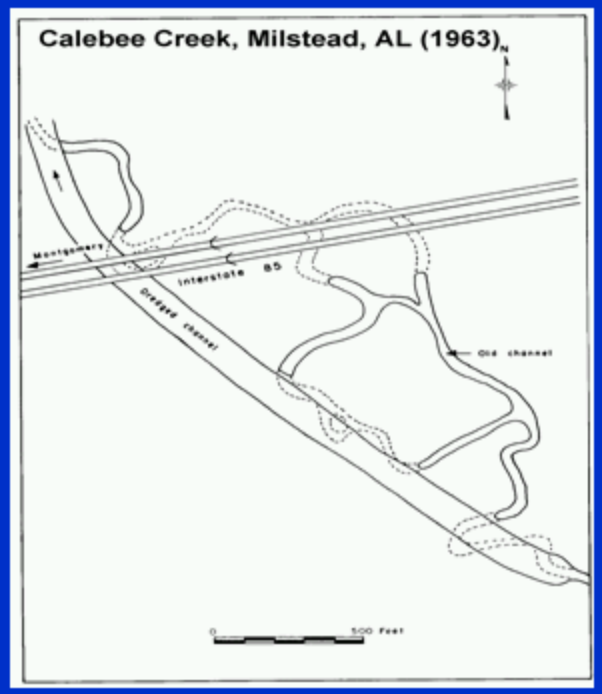
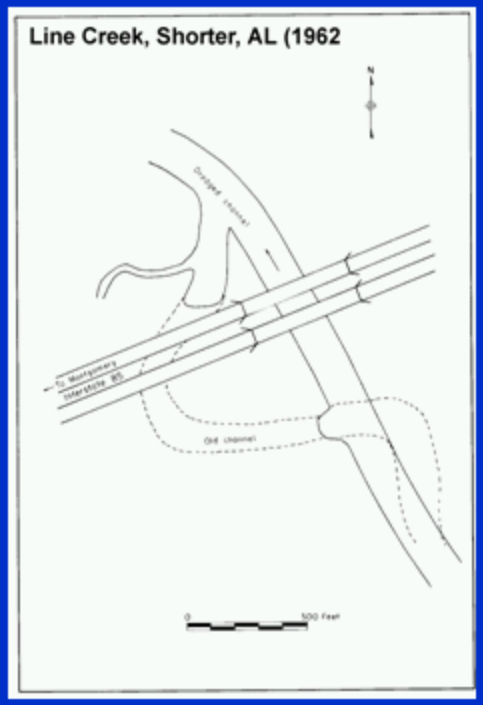
# Stream Channelization

**Stream realignments resulting from highway construction causes "head cutting" which results in a destabilized stream channel**

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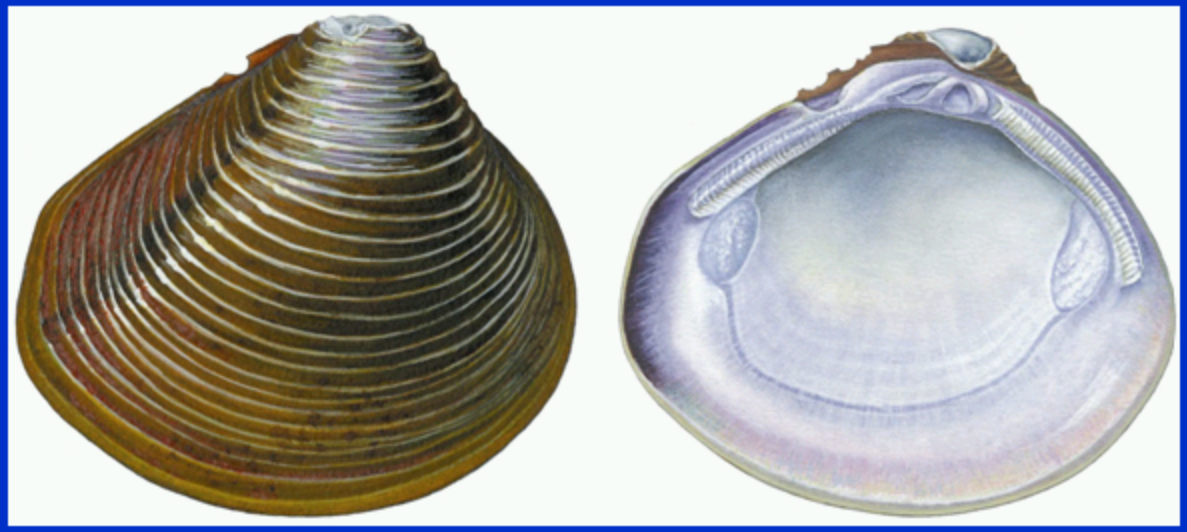
**Introduced Nonindigenous Mussels**

**Family -- Corbiculidae**

**Asian Clam**
***Corbicula fluminea***



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**Introduced Nonindigenous Mussels**

**Family Dreissenidae**

**Zebra Mussel**
***Dreissena polymorpha***

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## Introduced Cyprinid (Minnow) Fishes

***Mylopharyngodon piceus*, Black Carp feeds on mollusks**

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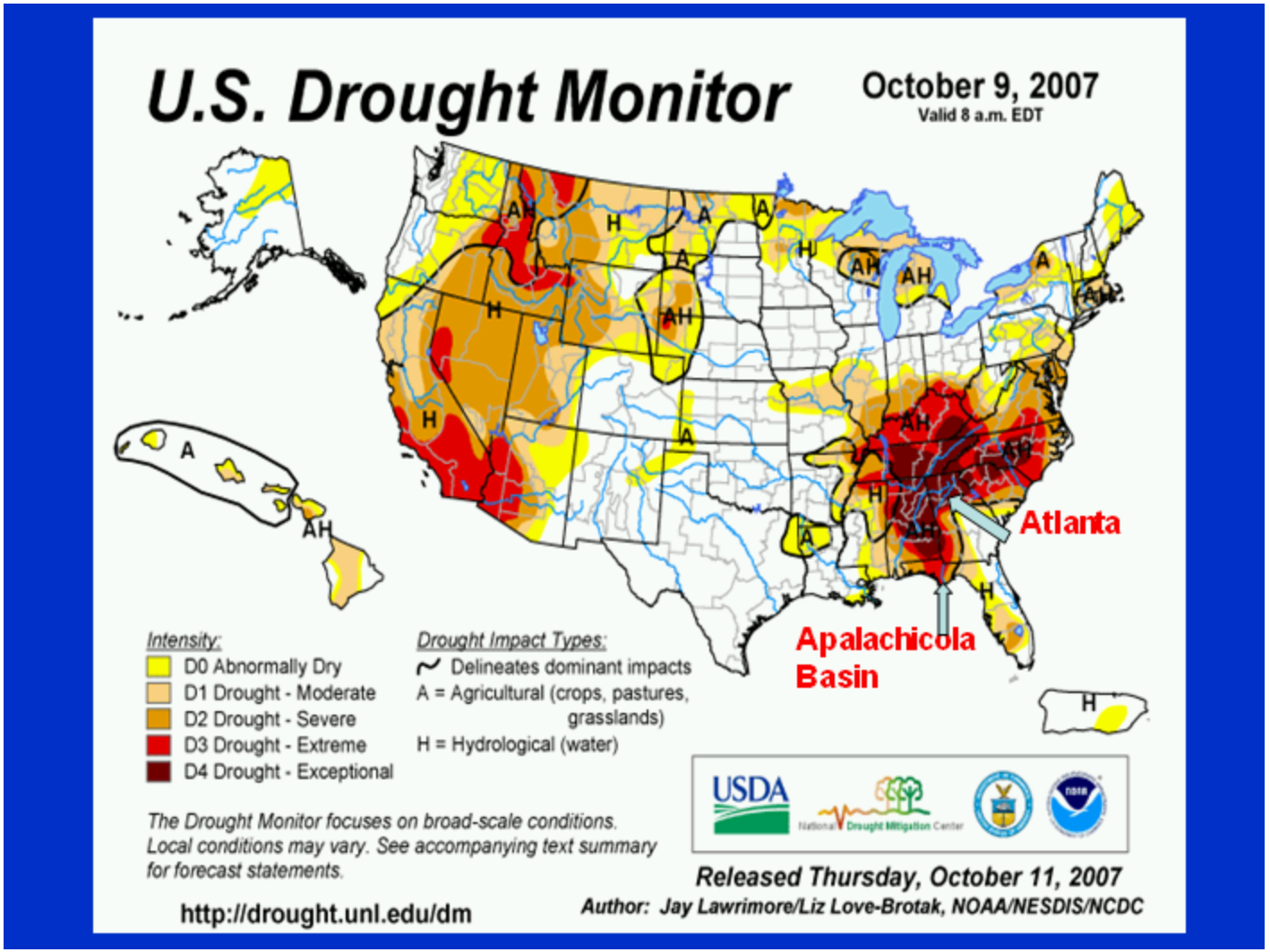
U.S. Drought Monitor
October 9, 2007
Valid 8 a.m. EDT
Atlanta
Apalachicola Basin
Intensity:
D0 Abnormally Dry
D1 Drought - Moderate
D2 Drought - Severe
D3 Drought - Extreme
D4 Drought - Exceptional
Drought Impact Types:
Delineates dominant impacts
A = Agricultural (crops, pastures, grasslands)
H = Hydrological (water)
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.
http://drought.unl.edu/dm
USDA
National Drought Mitigation Center
Released Thursday, October 11, 2007
Author: Jay Lawrimore/Liz Love-Brotak, NOAA/NESDIS/NCDC

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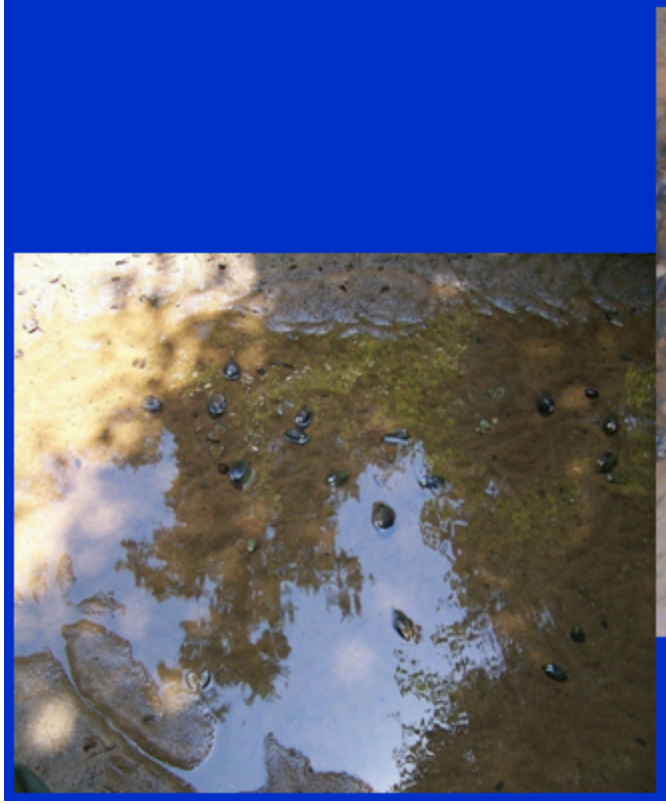
**Apalachicola River Florida near river mile 45**
**Endangered mussels drying out in isolated pools**
**(flow 6,000cfs at Chattahoochee, FL**



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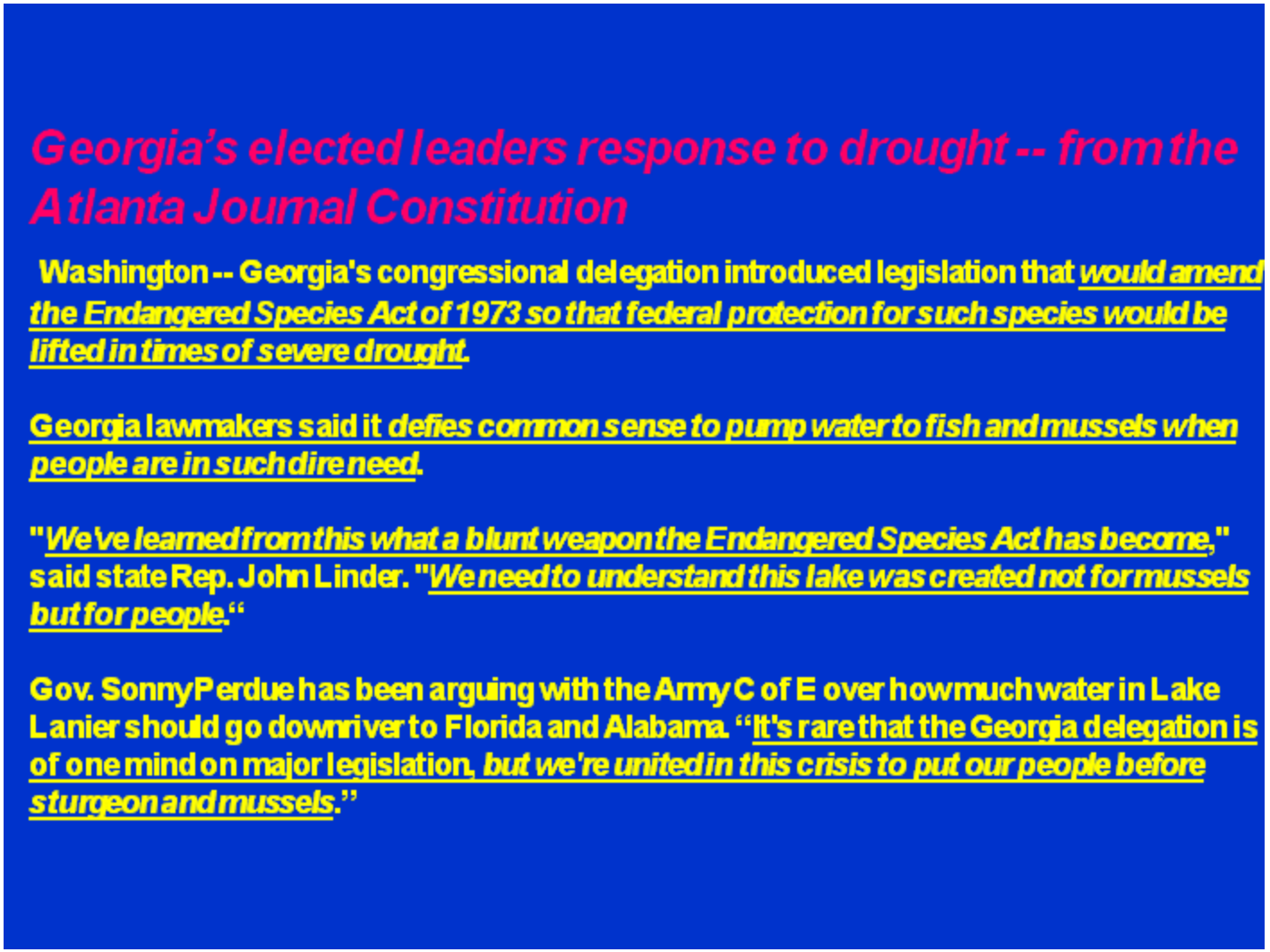
Georgia's elected leaders response to drought -- from the Atlanta Journal Constitution
Washington -- Georgia's congressional delegation introduced legislation that would amend the Endangered Species Act of 1973 so that federal protection for such species would be lifted in times of severe drought.
Georgia lawmakers said it defies common sense to pump water to fish and mussels when people are in such dire need.
"We've learned from this what a blunt weapon the Endangered Species Act has become," said state Rep. John Linder. "We need to understand this lake was created not for mussels but for people."
Gov. Sonny Perdue has been arguing with the Army C of E over how much water in Lake Lanier should go down river to Florida and Alabama. "It's rare that the Georgia delegation is of one mind on major legislation, but we're united in this crisis to put our people before sturgeon and mussels."

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Its the human population stupid!!
US Population 12/01/08 U.S. 305,785,674
Total population of the World 12/01/08 is 6,740,567,079

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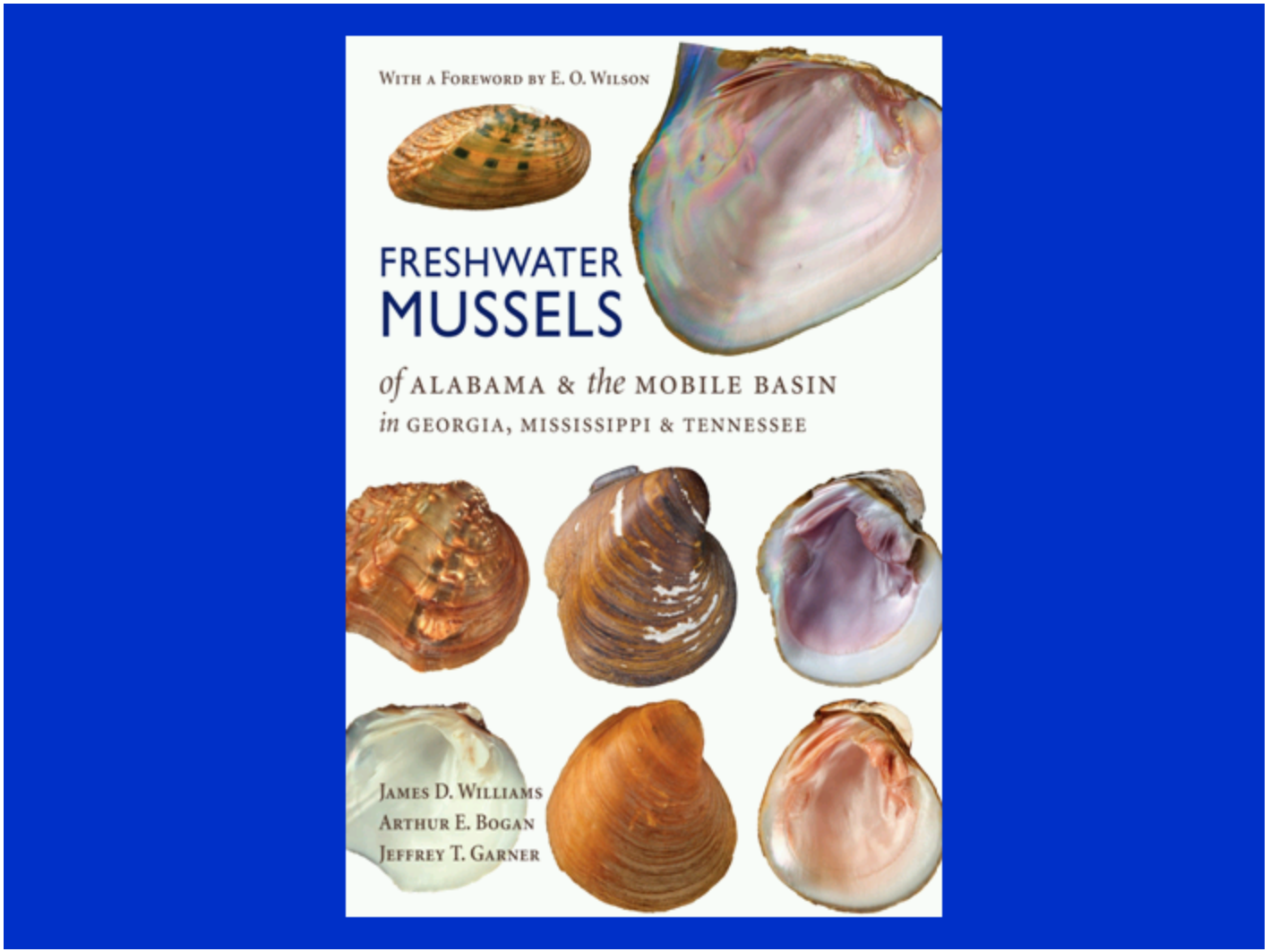
With a Foreword by E. O. Wilson
FRESHWATER
MUSSELS
of ALABAMA & the MOBILE BASIN
in GEORGIA, MISSISSIPPI & TENNESSEE
James D. Williams
Arthur E. Bogan
Jeffrey T. Garner

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